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BEYOND STATE CONTROL

Improvised and Craft-produced Small Arms and Light Weapons

G. Hays and N.R. Jenzen-Jones

small arms survey

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Credits

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Cover photo: A craft-produced sub-machine gun with an improvised suppressor design, produced by P.A. Luty in the United Kingdom. Source: N.R. Jenzen-Jones/ARES

About the authors

N.R. Jenzen-Jones is a military arms and munitions specialist and intelligence analyst focusing on current and recent conflicts and emergent technologies. He is the director of Armament Research Services (ARES). He has undertaken extensive research and analysis on a range of small arms and light weapons and small- and medium-calibre ammunition issues as well as on conventional arms proliferation; he has also produced numerous technical assessments of other weapon types, including incendiary weapons, cluster munitions, and indirect-fire artillery weapons. His other research fields include the exploitation of technical intelligence to support counter-piracy, counter-narcotics, and the use of explosive weapons in populated areas. He is a certified armourer and ammunition collector, and a member of international professional associations and societies such as the International Ammunition Association, the European Cartridge Research Association, the International Ballistics Society, the Society for Libyan Studies, and the Ordnance Society.

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List of abbreviations and acronyms

ACP	Automatic Colt Pistol
AECA	Arms Export Control Act
AMR	Anti-materiel rifle
ARES	Armament Research Services
AUD	Australian dollar
BRL	Brazilian real
CNC	Computer numerical control
CNY	Chinese yuan
EGP	Egyptian pound
FARC	Fuerzas Armadas Revolucionarias de Colombia
FATA	Federally Administered Tribal Areas
IED	Improvised explosive device
ILS	Israeli new shekel
INR	Indian rupee
IPG	Improvised Projected Grenade
IRA	Irish Republican Army
ITAR	International Traffic in Arms Regulations
ITI	International Instrument to Enable States to Identify and Trace, in a Timely and Reliable Manner, Illicit Small Arms and Light Weapons
LR	Long rifle
LYD	Libyan dinar
MANPADS	Man-portable air defence system
PoA	Programme of Action to Prevent, Combat and Eradicate the Illicit Trade in Small Arms and Light Weapons in All Its Aspects

PRIG	Projected Recoilless Improvised Grenade
RPG	*Ruchnoy protivotankovyy granatomyot* (handheld anti-tank grenade launcher)
RUC	Royal Ulster Constabulary
THB	Thai baht
UAV	Unmanned aerial vehicle
USD	United States dollar
YPG	Yekîneyên Parastina Gel (People's Protection Units)

Executive summary

Improvised and craft-produced small arms and light weapons are widespread in many parts of the world, even if they account for a small fraction of global holdings. More data is needed before researchers can arrive at a reliable estimate of these holdings, yet the figure is doubtless in the millions.

These weapons have been manufactured for as long as firearms have existed, typically by hand or in small workshops. Many are based on principles that are simple to replicate, such that individuals need only conduct minimal research to produce the most basic examples. However, advancements in materials science, production technologies, and globalized communications have meant that more effective and efficient designs are now available to criminals, armed groups, and pseudo-states. While craft producers are not manufacturing advanced man-portable air defence systems (MANPADS) or anti-tank guided weapons (ATGWs), they are constructing other types of light weapons—including mortars, recoilless guns, and grenade launchers—with some regularity.

This report presents the results of a long-term assessment of the broad and loosely defined field of improvised and craft-produced small arms and light weapons. In evaluating the nature and scale of production, acquisition patterns, and implications for law enforcement and policy, it identifies producers, users, and their motivations, along with emerging trends that may require monitoring and action. The study presents data and evaluations based on original and desk-based research, including interviews and hands-on technical appraisals of dozens of improvised and craft-produced weapons.

Improvised and craft-produced small arms and light weapons—which vary widely in terms of quality and safety—remain an important source of firepower for a wide range of actors, including tribal groups, poachers, criminals, insurgent groups, and even some states and quasi-state groups. In some areas, these weapons account for the vast majority of firearms used in crime; in others, their production is institutionalized, providing essential income for local gunsmiths. Some of these weapons are used locally, others are trafficked on a national, regional, or international scale. In Iraq, Libya, Syria, Ukraine, and elsewhere, armed non-state actors are regularly developing and employing new designs of improvised and craft-produced small arms and light weapons.

In the future, it may be possible to bypass traditional manufacturing and instead to produce entire firearms by using novel techniques, such as 3D printing. For now, however, most of those who cannot obtain conventionally-produced alternatives will continue to manufacture weapons using relatively low-tech means. Regardless of how they are made, improvised and craft-produced weapons will remain a significant constituent in the arsenals of non-state actors and criminal groups. At the same time, they will pose global challenges to law enforcement and policy-makers, who will require increasingly thorough documentation of their use in crime and conflict to be able to recognize trends and curb illicit proliferation.

Key findings

- The highest concentrations of craft-produced small arms appear to be among criminals outside of active conflict zones, especially in developing nations. In conflict and post-conflict zones, non-state armed actors generally engage in craft production of light weapons and their ammunition.
- In many developed states, including in Europe, strict laws aimed at limiting the proliferation of firearms appear to have encouraged the use of improvised and craft-produced weapons. In developing states, limited access to industrially-produced firearms remains a primary driver in the acquisition of improvised and craft-produced types, along with cultural factors.
- Among a limited number of long-range craft-produced weapons are rifles that feature repurposed, industrially-produced barrels. Some examples—such as those chambered for heavy machine gun calibres—are capable of engaging targets at more than 1,000 metres.
- The quality of some counterfeit craft-produced weapons is sufficiently high to fool non-specialist law enforcement officers and researchers. These weapons may be recorded according to spurious markings, including logos or serial numbers applied by dedicated engravers.
- Improvised and craft-produced small arms account for a sizable proportion of weapons seized in domestic law enforcement operations in several countries. In the UK, some 80 per cent of all guns used in crime in 2011 and 2012 were improvised, craft-produced, or converted;[1] in São Paulo, Brazil, 48 per cent of the sub-machine guns recovered during the same period were homemade; and in Indonesia, 98 per cent of the guns confiscated from robbery suspects in 2013 were homemade.
- The online sharing of expertise and instructional videos is facilitating the craft production of increasingly sophisticated weapons, including sub-machine guns and anti-materiel rifles.
- Improvised and craft-produced light weapons—including mortars, recoilless weapons, and grenade launchers—are produced with some regularity in most conflict zones. The sophistication of light weapons is on the rise and the rate of production of some weapons in certain conflict zones is nearing the industrial scale.
- The vast majority of improvised and craft-produced weapons do not meet international marking or record-keeping requirements, complicating law enforcement efforts to uniquely identify and trace them. Some alternative forensic techniques have shown promise in linking craft weapons to fired cartridges, however.

> “The quality of improvised and craft-produced weapons can vary from crude, improvised single-shot guns to semi-professionally manufactured copies of conventional firearms.”

Introduction

Before the advent of the production line and modern manufacturing methods, firearms and their components were constructed almost entirely by hand. The artisan makers who 'craft produced' these weapons were also the ones who developed specialized tooling. Since the establishment of gun-making centres in Europe, and later in its colonies, various types of gunmakers have copied professionally-produced firearms, usually with comparatively crude results, given that their equipment or skills have generally been significantly less advanced than those employed by professional gunsmiths.

Inevitably, techniques that prove difficult to replicate with limited means are replaced with those that can be implemented with less demanding technologies. Since the days of muzzle-loading cannon, guns have been produced using methods other than those used in mainstream manufacturing. Instead of casting guns in bronze or iron, contemporary copies might instead be produced in a crude composite fashion modelled after earlier guns, using metal hoops and staves or even organic materials such as rope and leather (von Archenholtz, 1788). Today's craft producers have embraced this spirit of expediency, in part by relying on the widespread availability of quality steel tubing, bar, sheet metal stock, and even polymer furniture. In addition, the Internet allows them free access to the information necessary to craft produce small arms and light weapons of many types.

Despite continual, incremental advances, modern firearms continue to be based on 19th-century engineering techniques. Consequently, individuals with the desire to undertake fairly straightforward research and acquire basic tools and equipment can manufacture viable homemade small arms. These items range from crude, single-shot 'zip guns' to shotguns, sub-machine guns, and rifles, including anti-materiel rifles.

Many light weapons are also based on principles that are fairly simple to replicate. Craft producers are thus able to manufacture mortars, recoilless guns, grenade launchers, and other light weapons with some regularity. There is no evidence, however, that any non-state armed groups or individuals are capable of producing viable examples of more advanced light weapons, such as man-portable air defence systems (MANPADS) and anti-tank guided weapons.

Since improvised and craft-produced weapons vary widely in terms of quality and safety, they are often considered inferior to industrially-produced types. Their use in conflict zones has increased, however, even where belligerents have had access to significant quantities of conventional military arms, as was the case in the recent crisis in Ukraine (Ferguson and Jenzen-Jones, 2015). Similarly, their use in various types of crime has become more prevalent, even in states with considerable small arms manufacturing capabilities. In some countries, such as Brazil and Indonesia, these weapons make up a sizable proportion of firearms seized in law enforcement operations. Moreover, criminal networks in a number of developing countries, such as the Philippines, oversee

near-industrial production, distribution, and sales in domestic, regional, and international illicit markets (Pavlovich, 2016).

This report is the product of a long-term assessment of the broad and loosely defined field of improvised and craft-produced small arms and light weapons.[2] In evaluating the nature and scale of production, acquisition patterns, and implications for law enforcement and policy, it identifies producers, users, and their motivations, along with emerging trends that may require monitoring and action.

The study presents data and evaluations based on desk-based and original research, including the authors' hands-on technical appraisals of dozens of improvised and craft-produced weapons; more than 20 author interviews with law enforcement and intelligence officials, deployed military forces, tribal leaders, and a range of non-state actors, conducted in eight countries from 2014 to 2017; and the proprietary ARES conflict materiel database.[3] Unless otherwise noted, the deductions made in this report are the authors'.

The report comprises eight main sections. The first provides a brief overview of applicable terminology and relevant characteristics. Section II offers some historical context for the development of improvised and craft-produced weapons. Section III discusses production methods, and Section IV considers what types of users obtain clandestine—and often illicit—weapons and why. The following three sections review improvised and craft-produced small arms, light weapons, and their ammunition. Safety and normative considerations are examined in Section VIII.

> “For the purposes of this study, the term ‘improvised and craft-produced small arms’ refers to small arms and light weapons that are fabricated primarily by hand in relatively small quantities.”

I. Terminology and characteristics

There are no commonly held technical definitions of *improvised and craft-produced weapons*. The United Nations has previously used the terms 'rudimentary firearms' and 'craft arms', defined as 'artisanal, home-made firearms or any firearm that has been assembled using parts and components manufactured for another utility or belonging to other firearms' (UNODC, 2015, p. 22). For the purposes of this study, the term 'improvised and craft-produced small arms' refers to small arms and light weapons that are fabricated primarily by hand in relatively small quantities—typically tens of weapons, as very few producers are able to manufacture hundreds, let alone thousands. Some observers further define improvised and craft-produced weapons as 'locally-made' or 'country-made'; others use the term 'expedient weapons' to highlight that they are of simple design, easily constructed, and made of readily available materials. They may be produced for personal, traditional, or organizational use, or for sale. Regardless of whether such manufacture is legal or illicit, it is often beyond state control.

A firearm, excluding ammunition, comprises two critical components: a barrel and a firing mechanism. At its most basic, a barrel is a tube that satisfies two criteria: its internal diameter can accommodate a cartridge and its composition allows it to withstand the gas pressures generated by firing the weapon. The firing mechanism can be similarly rudimentary; in some cases, the user provides the impetus by pulling the barrel back against a fixed firing pin or by applying a lit match to a hole drilled in the chamber.

Improvised and craft-produced firearms are commonly associated with poor reliability, accuracy, and safety standards. The manufacturers, who typically lack the production capabilities required to make rifled firearms, generally produce weapons that feature smoothbore barrels (ARES, 2018). Indeed, they often make use of readily-available or expedient sources of tubing in place of purpose-built firearms barrels. Gas piping, motor vehicle antennas, and bicycle frame tubing have all been used as barrels for improvised firearms.

The quality of improvised and craft-produced weapons can vary from crude, improvised single-shot guns to semi-professionally manufactured copies of conventional firearms. For the purposes of this report, an improvised weapon is distinguished from a craft-produced one primarily by the skill and tools required to produce it. Compared to the manufacture of improvised weapons, craft production requires a higher level of skill and greater access to specialized tools and equipment. Craft-produced weapons are closer approximations of their commercial counterparts than are improvised weapons, which are typically field-expedient designs that deliver substantially reduced capability. Generally speaking, improvised weapons take the form of single-shot firearms, simple mortar tubes, and certain grenade launchers. The producers of improvised weapons are rarely professional firearms manufacturers or gunsmiths.

Improvised and craft-produced weapons are often roughly made and thus characterized by an unfinished appearance, sharp edges, and visible means of construction, including large nuts, bolts, rivets, and weld lines. These features can also be found on factory-made firearms, notably wartime expedient designs such as the British Sten or any number of last-ditch military weapons produced by factions with limited or dwindling access to critical resources, such as Nazi Germany and Imperial Japan at the end of the Second World War. Since such weapons are relatively limited and well known, however, they can readily be distinguished from actual craft-produced weapons (Jenzen-Jones and Ferguson, 2018b).

Firearms that are craft-produced are sometimes difficult to distinguish from examples made by professional artisans. The distinction is primarily one of formality: weapons produced by professional artisans or boutique firearms manufacturing firms are typically subject to legal registration requirements, strict marking practices, and proof testing. Proof testing of firearms or their components[4] is conducted as a quality assurance and

Table 1 Non-industrially produced firearms, by type of manufacture

Type of weapon	Examples	Characteristics
Improvised	Single-shot firearms, simple mortar tubes, some grenade launchers	These are mostly expedient designs with substantially reduced capability compared to their conventional counterparts. The means of construction tend to be readily visible.
Craft-produced	Sub-machine guns, anti-materiel rifles, recoilless weapons	Production requires access to specialized tools and equipment as well as some technical skill.
	Copies and derivatives of commercial firearms	High-quality copies of commercial counterparts are produced independently of licensing arrangements and state oversight, making them difficult to trace.
Artisan or boutique	Shotguns and bolt-action rifles (significant variety exists)	Weapons are produced openly and are typically subject to legal registration and requirements, such as marking and proof testing.
Converted or 'reactivated'	Converted blank-firing weapons, often handguns; reactivated commercial firearms	These weapons vary significantly in quality; they may have a limited lifespan or be dangerous to the user.
Partially-finished commercial weapons	Various rifles and pistols	Assembled from parts kits or partially-completed components. These weapons are especially popular in the United States; they are legally restricted in many countries.

safety measure and may be carried out by independent organizations, government bodies, or manufacturers.

A few other categories of small-scale firearms manufacture overlap to some extent with that of improvised and craft-produced firearms. These include artisan and boutique firearms, converted and 'reactivated' weapons, and partially-finished commercial firearms, all of which are outside the scope of this study (see Table 1). The most significant overlap is the one with converted or reactivated weapons. These lethal-purpose weapons are produced by modifying non-lethal or less-lethal devices, such as blank-firing weapons, less-lethal launchers, and flare guns, or by 'reactivating' deactivated weapons[5] (Ferguson and Jenzen-Jones, 2016; King, 2015). The overlap lies in the technical requirements and manufacturing techniques used in the conversion of many types of weapons and the production of improvised and craft-produced firearms.[6]

The partially-finished commercial firearms—or 'parts kits'—listed in Table 1 are particularly prominent in the United States. In most cases, these kits contain foreign-made firearms whose receivers have been cut into several pieces.[7] The weapons are then rebuilt as originally designed or modified using other commercially-available components. Since these parts kits are rarely used as the basis for craft-produced weapons, they are not examined in this report. The assembly of weapons from parts kits and from so-called '80%' receivers merits further study, however.

Finally, due to a lack of available data, this study does not examine the craft-production of parts, components, or accessories, instead focusing on complete weapons. In developing nations, in particular, a lack of ready access to commercial after-market supplies means that users or local gunsmiths may fabricate parts, components, or accessories in order to repair or modify both conventionally-produced and craft-produced firearms. Craft-produced ammunition may also be developed,[8] particularly if certain types (such as suitable big game hunting ammunition) are not readily available (Y-man, 2013a; 2013b).

“The use of improvised cannon fielded in battle is well recorded in history, from Chinese ‘fire lances’ of the tenth century to experiments with makeshift cannon during the Boxer Rebellion of 1899–1901.”

II. Developmental history

Early history

The use of improvised cannon fielded in battle is well recorded in history, from Chinese 'fire lances' of the tenth century to experiments with makeshift cannon during the Boxer Rebellion of 1899–1901 (NAM, 1966). In eastern Asia, various rebel groups and armies crafted cannon barrels from wood and reinforced them with metal bands or leather; these were vastly cheaper and quicker to produce than cast-metal barrels. The practice of producing cheaper and simpler copies of European designs extended well into the early 20th century, when well-established cottage industries in Asia began to produce high numbers of low-quality copies of modern European firearm designs. These ranged from 'Khyber Pass' copies of Webley revolvers—most of which originated in what is now Pakistan's Khyber Pakhtunkhwa province—to the low-quality and sometimes oddly-configured copies of Mauser C96 and FN Herstal Browning M1900 self-loading pistols produced by small workshops during China's Warlord Era (Bin, 2014; McCollum, 2015a).

The late 19th and early 20th centuries saw an increase in bombings and arson attacks by various political groups in Europe, notably the Fenian campaign against British rule in Ireland. Following the Easter Rising in 1916, the Irish Republican Army (IRA) began to develop various improvised weapons, which would become the forerunners of those used during the 'Troubles'.[9] As early as 1917, IRA forces had established an underground factory to manufacture cast bodies and fuses for craft-produced hand grenades; an attempt to craft-produce a mortar in 1920 proved unsuccessful (NMI, n.d.; Oppenheimer, 2008).[10]

Second World War

Resistance groups in different theatres of the Second World War made use of a wide range of expedient craft-produced and improvised weapons. Governments of the period identified the need for simple weapons that could be produced quickly and cheaply, which led to the development of designs such as the British 9 × 19 mm Sten submachine gun and the US FP-45 Liberator single-shot .45 ACP pistols. Groups that were fighting the German occupation found copying the Sten relatively straightforward, even though their underground workshops were ill-equipped (Gander, 1990).

Perhaps the most famous and widely produced of these resistance-made guns was the Polish Błyskawica sub-machine gun, which was entirely assembled with machine screws rather than welding, and for which the components were serially manufactured in different locations (see Image 1). Early versions featured factory-made Sten barrels and magazines, two components that craft manufacturers often find difficult to replicate. The weapons were made in an underground workshop in Warsaw, which also

Image 1 A Błyskawica sub-machine gun manufactured by the Polish Resistance during the Second World War

© Leszek Erenfeicht via Forgotten Weapons

housed a soundproof test-firing range underneath a legal front business that manufactured chicken wire. The workshop manufactured about 755 Błyskawica sub-machine guns, many of which were used in combat (Erenfeicht, 2012).

In the struggle against Japanese occupation, the Pacific theatre saw the use of various improvised and craft-produced firearms. The most notable among them was a series of highly effective and easily manufactured improvised shotguns known in the Philippines as a *paltik* or *sumpak* (Oreta, 2011). These simple designs typically consisted of no more than two pieces of pipe and an end cap with a nail affixed in the middle. Designed to fire commonly-available shotgun cartridges, they could be manufactured quickly, with very limited skill. Following the war, one US company even manufactured and sold a copy commercially, naming it the Richardson Guerrilla Gun (Eger, 2017). This basic design—often referred to as a 'slam-fire shotgun' or 'slam gun'[11]—remains one of the most commonly encountered improvised firearm designs in the world (ARES, 2018).[12]

Mid-twentieth century

During the 1950s, the widespread use of 'zip guns' by teenage gangs of juvenile delinquents in the United States led various states to enact targeted legislation[13] to curtail their manufacture and possession. The practical knowledge and skill required to assemble simple single-shot firearms from readily-available materials spread quickly among street gangs, from city to city. One of the most common variations of these weapons involved adapting a child's toy cap gun by inserting a length of automotive antenna tubing in place of, or as an internal sleeve for, its ersatz barrel. Another construction method, notable for its simplicity, employed a handle carved out of wood, a barrel fashioned from automotive antennas, and elastic bands wrapped around a house key that was pinned at its keyring hole, allowing it to pivot as a hammer. Although many of these

Image 2 A crude improvised firearm produced during the Kenya Emergency by Mau Mau forces

Note: This zip gun-type weapon originally used several strands of material taken from bicycle inner tubing to provide impetus to the firing pin.

© Imperial War Museum

weapons were highly inaccurate and frequently injured the shooter, several injuries and murders were attributed to the use of such weapons (Ellison, 1961; Van Pelt, n.d.).

The Indochina Wars, which culminated in the US involvement in Vietnam, turned on unconventional and guerrilla warfare, setting the stage for the extensive use of improvised and craft-produced weapons by insurgents. Many of these were victim-operated improvised explosive devices (IEDs), although a sizable number were improvised firearms, several examples of which are now held by collectors or in museums. While most of these firearms were crude single-shot weapons, insurgents developed a number of impressive handmade copies of conventional firearms, such as the Colt 1911 automatic pistol and British 9 mm STEN sub-machine gun (McCollum, 2016; US Army FSTC, 1964). In other conflicts, including the Mau Mau Uprising in Kenya and the anti-British rebellion in Cyprus, insurgents supplemented their limited stocks of conventional weapons with crude improvised firearms and mortars (Ferguson, 2008; IWM, 1955; NAM, 1994; see Image 2).

Recent and current use

Many of the non-state armed groups of the 21st century employ improvised small arms and light weapons in conflict and crime (ARES, 2018).[14] While these weapons are often overlooked or sensationalized, recognizing and assessing their capabilities, origins, and designs remains key to understanding modern firearms violence. A 2015 UN report found that, in several countries, seizures of improvised and craft-produced firearms accounted for 5, 10, or even 24 per cent of the total number of seized firearms (UNODC, 2015, pp. 22–23).

Improvised firearms can have a significant impact on modern conflicts, as evidenced by the use of the Borz sub-machine gun in both Chechen conflicts (1994–96 and 1999–2009) and the widespread use of such systems by non-state armed groups in ongoing fighting in Iraq, Syria, and Yemen (ARES, 2018; Lyamin and ImproGuns, 2017; McCollum, 2017). Technical similarities between current designs and their earlier counterparts

remain, yet the scale and quality of production for some improvised weapons in some regions can be described as near-industrial. They are now produced in much higher numbers than previously possible, and to a much higher standard.[15] Technical expertise can be shared across continents and between groups using a variety of methods, now most commonly via the Internet (see Box 1). The recent influx of technically-trained personnel from both the Iraqi and Syrian armies into insurgent groups has compounded the effects of such knowledge transfers in modern conflict (Singh, 2017).

Box 1 Transfer of designs and know-how

In the absence of technical skill, perceived reliability and user safety issues can inhibit the development of successful craft-produced weapon design. Knowledge sharing can help to jump-start the process, particularly with respect to the construction of weapons that have already been successfully tested.

Among the primary sources informing improvised and craft-produced firearm design are the 'cookbooks' of the 1960s and later years. Some emerged as various publishers adapted unclassified US Army manuals available in the public domain, often simply by copying and rebranding the contents. Such army manuals contained instructions for manufacturing improvised mines, grenades, mortars, and rockets, as well as incendiary devices and various fuses, detonators, and delay mechanisms. They also included step-by-step instructions on how to make improvised firearms from standard pipe fittings, which inspired later commercial cookbooks (Jenzen-Jones, 2017a).

In the early 1960s the Minutemen, a militant anti-communist network operating in the United States, published mail-order newsletters containing information on guerrilla warfare tactics and suggestions for procuring weapons and explosives for a doomsday scenario. Perhaps the most significant offering was a set of plans for a .45 ACP-calibre sub-machine gun that could be constructed for less than USD 7 from parts available at any hardware store. Two decades on, the same design was highlighted in other how-to publications, some of which also included instructions for the preparation of nitroglycerine and the construction of improvised silencers. A popular firearms magazine of the time later featured an article in which a staff writer constructed the weapon from cookbook plans and test-fired it (Jenzen-Jones, 2017a).

The niche literature also showcased a version of the Filipino *paltik* or *sumpak* improvised shotgun, emphasizing that it could be assembled without tools or any particular skill. One author dubbed the weapon the 'Four Winds Shotgun' and noted that it could be constructed from four components that could be sourced from any hardware store. After use, it could be disassembled and the four parts cast 'to the four winds'—that is, discarded separately in order to confound law enforcement (Jenzen-Jones, 2017a).

One cookbook series included plans for the construction of a weapon loosely based on the German Armbrust recoilless launcher. British security forces claimed that such diagrams were the basis for the PRIG—the Projected Recoilless Improvised Grenade—developed by the IRA in the early 1990s.[16]

Image 3 An expedient craft-produced 9 × 19 mm sub-machine gun designed by P.A. Luty, seized from the designer when he was arrested and used to effect his conviction in 1998

© N.R. Jenzen-Jones/ARES

To this day, the sub-machine gun plans of British author P.A. Luty remain in worldwide circulation among hobbyists (Jenzen-Jones, 2017a). Luty described his instructions as 'simple enough for any would-be home gunsmith to put into practice', noting that he relied on the use of 'standard hardware products which would not arouse suspicions when purchased or left "lying around"' (Jenzen-Jones, 2017a). Copies and derivatives of his design have been found among biker gangs in Australia and Islamist terror groups in Indonesia (ImproGuns, 2014d; n.d.). Luty was sentenced to four years' imprisonment in April 1998, charged with manufacturing a prohibited weapon and possession of ammunition without a certificate (Bruce and Male, 2005; see Image 3). He passed away in 2011, prior to his scheduled trial on further charges under the Terrorism Act 2000, specifically of 'making a record of information likely to be useful to a person committing or preparing an act of terrorism' (Gardner, 2011).

Many of the books, magazine articles, and other publications containing instructions for the manufacture of improvised and craft-produced weapons have since been digitized and are readily available via the Internet. Home gunsmiths and hobbyists—including those who produce firearms legally in countries such as the United States—regularly post technical know-how and techniques related to home gunsmithing and the manufacture of arms on YouTube and other social media platforms. In some cases, non-state armed groups have also produced online documents, guides, and videos that provide instructions for the manufacture of improvised or craft-produced weapons. Various armed groups in Iraq and Syria, for instance, have posted videos focused on the design and construction of anti-materiel rifles (ARES, 2018).[17]

“Individual gunsmiths are often skilled local blacksmiths or engineers, while others may have learned firearms manufacturing as a family trade.”

III. Methods and scale of manufacturing

Unskilled production

Manufacturers of improvised firearms and the most basic craft-produced weapons are equipped with very limited tools and possess only rudimentary knowledge and skill. They typically work in residential settings, producing limited numbers of weapons for use by individuals or small groups, such as criminal gangs, sometimes for profit (see Image 4).[18] While crude, single-shot improvised firearms appear to constitute the great majority of weapons in this category, detailed plans available in books or via the Internet allow for the production of more technically complex firearms with the same basic tools. Other items in this category are adapted from otherwise innocuous items, such as staplers or nail guns, as well as simple light weapons, such as improvised mortar tubes (Hays and Jenzen-Jones, 2016).

Local artisan production

In developing and newly industrialized nations, skilled craftsmen produce firearms either for profit or in line with the local cultural heritage. Individual gunsmiths are often skilled local blacksmiths or engineers, while others may have learned firearms manufacturing as a family trade.

Image 4 Slam-fire shotguns seized from a makeshift workshop used by a gang in Buenos Aires, Argentina

© Policía Metropolitana de Buenos Aires via Facebook

Image 5 An Egyptian gunsmith arrested in 2014

Note: This image also shows a variety of hand tools and a drill press.

© *Almogaz* via Facebook

Manufacture typically takes place in areas with few local or national regulations regarding the production and sale of firearms, or where there are substantial enforcement challenges. Local gunsmiths tend to work from a dedicated manufacturing workshop equipped with typical small workshop equipment (Hays and Jenzen-Jones, 2016). At this level, they are generally capable of producing simple craft-produced firearms chambered for modern cartridges. Alternatively, they may work from primitive forge facilities, suitable for producing traditional black-powder weapons.

Most operations necessary for the manufacture of firearms can be carried out using lathes, pillar drills, and belt grinders, as well as simple hand tools such as files (see Image 5). This is not surprising given that, historically, gunsmiths made do with an even smaller toolset that was exclusively hand-powered. Local producers generally exploit local sources of materials, including scrap metal and steel water pipe, which can be repurposed as smoothbore barrels. Unfinished weapons are often passed on to other artisans, who provide higher-quality finishing and engraving, adding commercial value to the final product (Stocker, 2008).

In areas where craft production takes place, it can be a livelihood for families. Many manufacturers rely on the trade as their primary—or as an important secondary—source of income, particularly in developing countries.[19] Whereas crops such as corn or cassava can take six months or more to provide income, craft-production of firearms may allow for a much faster turnaround on an artisan's initial outlay, as weapons can often be produced in 12 hours to a week. Increased demand for weapons sometimes drives prices up, making the trade more attractive to artisans. In Ghana, for example, a craft-produced smoothbore gun was valued at USD 60 in June 2001. By August 2002,

the price had risen to USD 150, and demand for Ghanaian guns had been identified in Benin, Burkina Faso, Côte d'Ivoire, Nigeria, and Togo (Batchelor, 2003). In these areas, the industry is so interwoven with cultural traditions that improvised and craft-produced firearms remain critical to the defence of families, tribal groups, and villages, as well as hunting, poaching, and trade.

Semi-professional production

Semi-professional manufacturing operations may employ multiple skilled workers to produce modern firearms, including high-quality copies of commercial weapons, for both illicit and semi-legitimate local markets. Large operations may make use of industry-standard techniques and equipment such as computer numerical control (CNC) lathes and milling machines (see Image 6); in smaller workshops, most of the work is done by hand using relatively primitive equipment. In both cases, such operations produce a large number of firearms that are usually supplied in bulk to a distributer. Craft production of firearms sometimes takes place in otherwise legitimate industrial facilities, with or without their owners' knowledge. [20] While the distinction between traditional commercial manufacturers and semi-professional production is not sharply defined, the latter is usually conducted in contravention of local and national laws and regulations. Likewise, sales of these weapons typically take place without any form of registration or record.

Commercial finishing techniques such as bluing or phosphatizing,[21] the hardening of components, and the presence of (often falsified or counterfeit) markings are typical of weapons in this category. Barrels may also be rifled via broaching[22] or produced from commercial barrel blank stock.[23] Many of these weapons are effectively high-

Image 6 A CNC milling machine showing a loaded programme used in the illicit production of components of TEC-9-type craft-produced sub-machine guns in Montreal, Canada

© Royal Canadian Mounted Police

quality copies of their commercial counterparts, produced without licensing arrangements, registration, or other requirements (see Box 2). Weapons produced in this way are typically much more difficult to trace. As a result of these factors, the market for firearms produced in this category is limited and primarily supplies criminals and criminal organizations.[24]

Semi-professional production, including of counterfeit weapons and of ammunition, is commonplace in the town of Darra Adam Khel in the Khyber Pakhtunkhwa province of

Box 2 Copies of industrially-manufactured weapons

Copies of industrially-manufactured weapons are becoming increasingly common in the inventories of both insurgent groups and criminal organizations. Producers of such copies capitalize on known designs, brand names, and trends associated with the small arms and light weapons markets. While armed non-state actors tend to obtain these weapons when industrially-manufactured alternatives are not available, a limited number of copies have been sold to unwitting purchasers.[25] Criminal groups may also select to acquire these weapons in view of their forensic implications (Aquino, 2014).[26]

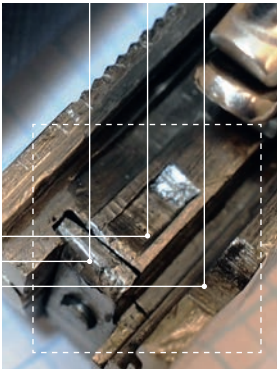
Numerous counterfeit weapons are produced in the Philippines, with the city of Danao—known locally as 'Gun City'—home to the largest concentration of gun manufacturers in the country. The gunsmiths of Danao have manufactured firearms since the days of Spanish colonial rule (Ramos, 1982; 2005). Some counterfeit weapons from the Philippines have made their way onto the international market, including numerous derivatives of the Colt 1911 self-loading pistol and various Smith & Wesson revolvers.

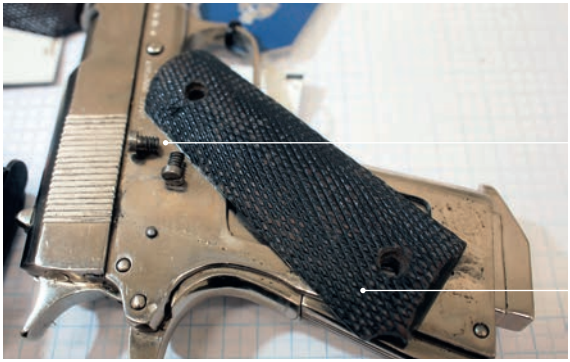
Some counterfeit weapons produced by semi-professional illicit manufacturers pass for authentic. Upon cursory inspection by an investigator, certain self-loading pistol copies made in Danao, for example, are of high enough quality to be mistaken for the genuine article—a testament to the ability of at least some Danao gunsmiths, who produce many of their weapons by hand with little in the way of machinery. Fake markings on such guns can be difficult to distinguish from originals, particularly the ones made by separate skilled craftsmen who specialize in finishing weapons, including dedicated engravers who apply counterfeit logos and serial numbers (ATF, 2010; Pavlovich, 2016). As a result, law enforcement officials sometimes misidentify seized examples, recording them according to spurious markings.[27]

Close inspection tends to reveal tell-tale signs of manual production, however, including tool marks and a rough overall finish of components (see Image 7). Forensic investigative techniques include comparing tool marks and metallurgical testing. Experienced firearm examiners have concluded that some handmade components are not interchangeable between craft-produced firearms of the same model that are produced in quantity. It is thus not possible to guarantee that smuggled components can be assembled into a functional weapon, even if they are the products of a single manufacturer (Pavlovich, 2016).

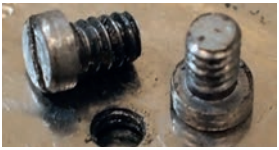
Image 7 A Danao-made copy of the Colt 1911 displaying characteristic tool marks compared with a genuine factory-made example (top) and grip panels showing telltale signs of hand manufacture (bottom)

Hand-tooled characteristics such as coarse and uneven toolmark stripe, and poor overall finish





Handmade screws



Hand cut checkering

Handsaw marks evident on the underside of the wooden grips

© Steven Pavlovich/
Western Australia Police Force

Pakistan, where craftsmen have produced copies of firearms for more than a century (Ahmad, 2012; Ewart, 1930). Produced on a relatively large scale for commercial reasons, weapons and ammunition in the region include copies of modern self-loading service rifles that are reportedly fit for use in the field. Darra-made weapons have been used by Taliban insurgents as well as private militias and government personnel in both Pakistan and Afghanistan (ARES, 2018).

> “The acquisition of improvised and craft-produced weapons is associated with a greater likelihood that they will be used for lethal or criminal purposes than the purchase of conventionally-produced firearms.”

IV. Users and global proliferation

Why use improvised and craft-produced weapons?

Individuals, groups, and states may choose to acquire and employ improvised or craft-produced weapons for a variety of reasons, be they political, economic, social, cultural, or historical (Batchelor, 2003). Such weapons are generally acquired in the absence of viable alternatives, or when their use is considered preferable to commercially-manufactured alternatives. In broad terms, users acquire improvised or craft-produced weapons if they have a short- or long-term demand for weapons—such as to fill a capability gap, for commercial reasons, or for criminal purposes—and when at least one of the following is also true:

- they have limited funds;
- there is a local dearth of industrially-produced weapons;
- they want a weapon that is difficult to trace;
- they want a weapon that is easy to conceal;
- they want a weapon that has an unusual appearance;
- the weapon is selected for cultural reasons; or (in rare instances),
- they have been duped into buying a counterfeit weapon (see Box 2).

Improvised and craft-produced weapons are most commonly acquired and employed when commercial alternatives are not available or are prohibitively costly. This approach has been applied by individuals, criminal groups, and insurgent groups—from the wartime Polish resistance to Jaish al-Islam to Nigerian tribal militias. The cost of improvised and craft-produced weapons is generally lower than that of industrially-manufactured alternatives, although the prices can vary significantly by region and circumstance (ARES, 2018; see Table 2).

In some cases, a preference for weapons that are harder to trace may lead some criminal users to settle for a less-capable improvised or craft-produced weapon rather than a professionally-manufactured alternative (Mediana, 2013). Some studies have reasonably concluded that the acquisition of improvised and craft-produced weapons is associated with a greater likelihood that they will be used for lethal or criminal purposes than the purchase of conventionally-produced firearms (Batchelor, 2003). In certain settings, such as West Africa, however, hunting remains the primary use for improvised and craft-produced small arms and light weapons (Assanvo, 2017). Still, some of these firearms may be used in criminal hunting activities, such as poaching.

Improvised and craft-produced weapons may be used simply to acquire a conventionally-produced weapon, through theft or the killing of an enemy combatant. Such was the design intent behind the mass-produced FP-45 Liberator;[28] it is also a tactic employed by various rebel groups around the world (Canfield, 2012). In April 2004, for example, a Chechen separatist used a Borz craft-produced sub-machine gun to kill two Russian

Table 2 Pricing of selected improvised and craft-produced weapons

Type	Country	Model	Price[29]	Source
Pen guns and zip guns	Australia	Modified automatic centre-punch	AUD 100 (USD 80)	Partridge (2014)
		Pen gun	AUD 100 (USD 80)	Harris (2015)
		Various zip gun designs	AUD 100 (USD 80)	Morri (2015)
	Thailand	.22 LR & .38 Special	THB 800–1,450 (USD 24–43)	ARES (2018)
Shotguns and muzzleloaders	Nigeria	Dane gun	USD 50	Hinshaw (2014)
		Muzzle-loading shotgun	USD 24	Hinshaw (2014)
	Thailand	Slam-fire shotgun	THB 1,500 (USD 45)	ARES (2018)
Single-shot pistols	Egypt	Fard/marotta	EGP 500–1,000[30] (USD 28–56)	Elmeshad (2011)
	India	Desi katta	INR 500–1,000 (USD 8–15)	Bhosle (2015)
	Thailand	.22 LR 'derringer'	THB 3,900 (USD 117)	ARES (2018)
		Break-barrel (12-gauge)	THB 6,800–8,000 (USD 200–240)	ARES (2018)
		Break-barrel (.38 Special)	THB 6,100–7,000 (USD 180–240)	ARES (2018)
Revolvers	Philippines	NNA mini copy (.22 LR)	AUD 150 (USD 120)	Pavlovich (2016)

Type	Country	Model	Price[29]	Source
Self-loading pistols	China	Type 64 copy	CNY 10,000[31] (USD 1,500)	Hu (2010)
	India	'Morena'/MP pistol	INR 5,000–6,000 (USD 78–90)	Agha (2014)
	Libya	.32 ACP design	LYD 600 (USD 450)	ARES (2018)
Sub-machine guns	Australia	Ingram MAC type	AUD 15,000 (USD 11,840)	Hills (2013)
		P.A. Luty type	AUD 15,000 (USD 11,840)	Fewster (2014)
		Ingram MAC type	AUD 5,000–15,000 (USD 3,950–11,840)	Pavlovich (2016)
	Brazil	Ingram MAC type	BRL 5,000 (USD 1,560)	Ferreira (2016)
		Sten type	BRL 5,000 (USD 1,560)	Lombardi (2002)
		Sten type (very crude)	USD 1,250	ARES (2018)
		Various	BRL 3,500 (USD 1,090)	ARES (2018)
	Israel/Gaza	'Carlo' (unrifled)	USD 500–1,000	ARES (2018)
		'Carlo' (unrifled)	ILS 3,000–10,000 (USD 750–2,500)	Gross (2016)
		'Carlo' (rifled)	ILS 10,000–15,000 (USD 2,500–3,800)	Gross (2016)
	Philippines	Ingram MAC type	AUD 400–1,500 (USD 315–1,800)	Pavlovich (2016)
	Russian Federation (Chechnya)	Borz	USD 100	Dudayev (2004)

officers in Grozny, before immediately taking their weapons and escaping (Dudayev, 2004). Even if stealing a victim's weapon is not an insurgent group's primary motivation, it may opportunistically pursue the acquisition of more capable weapons.

Use due to a lack of available alternatives

The Palestinian militant organization Hamas serves as a useful case study with respect to analysing motivations for the production and use of improvised and craft-produced weapons by non-state armed groups. International sanctions and arms embargoes—and the consequent lack of arms supplies—can be a key driving force behind a group's decision to develop expedient weapons. Hamas may be the most well-documented case in point. In view of the limited and unreliable supply of professionally-manufactured munitions, Palestinian insurgent groups, including Hamas, make use of basic construction materials, such as steel tubing and sheet metal, to craft-produce Qassam[32] rockets.

Since Hamas began to employ Qassam rockets in 2002, the rocket has become synonymous with Israeli–Palestinian tensions. Even when the supply of professionally-manufactured weapons is entirely cut off, the movement of materials used in the manufacture of Qassam rockets is difficult to restrict. Put simply, it is more viable to use basic materials to manufacture weapons in-country than to try to smuggle complete rockets when strict controls are in place. However, both methods of acquisition are often attempted simultaneously (IDF, 2016; *Times of Israel*, 2016).

Many other non-state armed groups in the Middle East and North Africa are currently employing techniques similar to those of Hamas, including a number of groups that are fighting in Iraq and Syria.[33] Jaish al-Islam, for one, has made sustained use of improvised and craft-produced systems. Like Hamas, Syrian rebel groups hold these weapons in their inventory due to a dearth of conventionally-produced alternatives. Yet unlike Palestinian groups, which typically have to smuggle various materials into Gaza to produce such weapons, Jaish al-Islam controls the supply of equipment and materials required for weapons production, as the group previously held large areas of the industrial city of Adra.

While operating under siege conditions, cut off from primary rebel enclaves, Jaish al-Islam employed improvised munitions alongside conventionally-produced weapons. Since the group had the equipment, materials, and expertise required for the semi-professional production of small arms and light weapons, it was able to sustain its position and refine its manufacturing techniques despite the high-pressure siege, in part by relying on the minimal transfer of supplies through Syrian government lines. It has routinely employed techniques such as sand casting[34] to produce mortar ammunition that is broadly on par with industrially-produced models (ARES, 2018; Jenzen-Jones, 2018; see Image 8).

Image 8 Jaish al-Islam uses the sand casting technique to produce mortar projectile bodies, 2014

Reproduced from: ARES (2018)

Two key factors led Jaish al-Islam to develop various improvised light weapons: the group already had ammunition and it was encircled by the Syrian Arab Army. The most iconic of these systems is sometimes known as the 'Hell Cannon', properly conceived of as a series of improvised mortar and smoothbore gun designs.[35] Similar basic designs have also appeared in Colombia, Iraq, Northern Ireland, and elsewhere. Such weapons are almost exclusively employed when the supply of industrially-produced alternatives is severely limited or non-existent (ARES, 2018).

Preference for craft-produced weapons

While necessity dictates the use of improvised and craft-produced weapons in the vast majority of cases, they are sometimes used by preference. Improvised and craft-produced weapons are typically outclassed in every aspect by their professionally-manufactured counterparts, yet they often prove very difficult to trace and may therefore be attractive in a number of circumstances. Indeed, they may be selected as a way to confound law enforcement, be it with absent or erroneous markings, a lack of rifling, or unusual cartridge types (Van Brocklin, 2015).

Modern investigative techniques and tracing procedures rely on characteristics such as the presence of serial numbers and other markings, striations imparted to fired projectiles by rifling (and other tool marks), and propellant signatures. Improvised and craft-produced small arms and light weapons may go some way towards defeating these methods.[36]

In some regions, the use of improvised and craft-produced weapons is the norm. In these contexts, criminal groups and individuals may wish to use relatively common and unremarkable weapons. The manufacture of such weapons often takes place in ungoverned settlements, in close proximity to major urban centres, especially in Latin

Image 9 A high-quality craft-produced sub-machine gun seized in Brazil

Note: It appears to make use of a 9 × 19 mm Uzi magazine and includes a collapsible stock for concealability.

© Polícia Rodoviária Federal

America and the Indian subcontinent (Kilcullen, 2013). The firearms are often of small size, allowing for ease of concealment, an essential characteristic for those operating in busy urban centres such as São Paolo or Bangkok (Bricknell, 2008; see Image 9).

There may also be cultural reasons for, and influences on, the manufacture and use of improvised and craft-produced weapons, especially where similar methods of production and employment have been dominant for many decades.[37] In many parts of the world, craft production may originally have been a traditional custom, undergirded by cultural norms that cast firearms as a symbol of masculinity, status, and prosperity. In South Africa, craft production accelerated under apartheid but has since evolved into a driver and tool of criminal activity. In the tribal regions of Pakistan and Afghanistan, local arms production was originally driven by a desire for collective community defence and self-defence, before evolving into a principally economic activity (Batchelor, 2003).

Limitations of improvised and craft-produced firearms

The majority of improvised and craft-produced firearms are of limited effectiveness. They are most useful—and most often used—in densely populated urban centres. Organized criminal groups, in particular, employ weapons that are highly inaccurate and effective only at very short ranges. These firearms have short, unrifled barrels with excessive windage[38] and poor or absent sight systems; they typically fire pistol-calibre ammunition, often using an automatic operating system. Nonetheless, the number of craft-produced long-range rifles is limited. Many feature repurposed, industrially-

produced barrels. Some examples—such as those chambered for heavy machine gun calibres—are capable of engaging targets at more than 1,000 metres.

Improvised and craft-produced muzzle-loading weapons, often manufactured in West African countries such as Ghana, also possess obvious limitations. While they generally have longer barrels than other craft-produced small arms, they are unrifled, very basic, and almost invariably single-shot weapons (Berman, 2011).

Craft-produced light weapons also suffer from inaccuracy and a lack of reliability. The use of improvised explosive projectiles can have serious consequences for the operator and others in the case of a catastrophic failure. Indeed, the risk of inaccurate fire represents a serious threat to civilians, especially when craft-produced light weapons are used in an indirect-fire role.

The craft production of small arms and light weapons by an armed group often has operational and strategic limitations. The manufacture of these weapons can be wasteful and inefficient, and the end product is often of very poor build quality. Most sustainable criminal or non-state armed forces that manufacture such weapons aim to use them to fill a capability gap for a limited time only. Such groups often seek to refine their designs and improve their manufacturing capabilities, as evidenced by the Provisional IRA's transition from the Improvised Projected Grenade (IPG) to the Projected Recoilless Improvised Grenade (PRIG). Similar enhancements can be traced across the various marks of improvised mortars the group adopted and employed over the course of their insurgency (Oppenheimer, 2008).

In general, non-state armed groups seek to replace improvised and craft-produced systems with conventionally-manufactured weapons of a higher standard. During that transition, many rely on battlefield capture to supplement their homemade weapons—a trend documented in Libya, Syria, and elsewhere (ARES, 2018). Where this approach proves difficult, as in the case of Hamas, a reliance on ongoing craft production may limit the operational effectiveness of the group, in part dictating which operations it can perform. Improvised and craft-produced firearms are thus not only limited in technical terms; reliance upon such weapons may directly limit the effectiveness of the groups employing them.

Types of users and producers

Users of improvised and craft-produced small arms and light weapons run the gamut from individual hobbyists to non-state armed groups (see Table 3). As the globalized economy enables swift trade in basic materials, tools, and components, and as digital communication systems allow for an instant exchange of techniques, technical plans, and information over the Internet, the types and motivations of users are expanding (Kilcullen, 2011).

Table 3 Users and producers of improvised and craft-produced weapons, their motivations, and associated risks

Users and producers	Primary motivations for acquisition or production	Associated risks
Tribal groups and families	Cultural reasons, limited availability of conventional firearms, hunting, deterrence, self-defence	A decline in access to or production of craft weapons may lead to an increased use of commercial weapons. Craft weapons may be used in conflict.
Hobbyists and collectors	Interest	Minimal direct threat to others, although the sharing of know-how online may facilitate production by and proliferation among criminals and non-state armed groups. If poorly designed, the weapons may harm users if fired.
Gunsmiths and engravers	Livelihood or supplemental income (see Section III)	Production is unregulated and contributes to illicit proliferation, including of semi-professional copies of commercially-available weapons.
Subsistence poachers	Limited availability of conventional firearms, livelihood	Possession facilitates crime. Safety issues may threaten users and bystanders.
Traffickers	Limited availability of conventional firearms, profit (see Box 3)	Trafficking exacerbates illicit proliferation and the arming of non-state armed groups.
Individual criminals	Limited availability of conventional firearms, low cost, limited traceability, easy concealment	Possession facilitates crime. Safety issues may threaten users and bystanders.
Criminal organizations	Limited availability of conventional firearms, low cost, limited traceability, easy concealment	Possession facilitates crime. Safety issues may threaten users and bystanders.
Insurgent groups and militias	Limited availability of conventional firearms, filling capability gaps, supplementing holdings or facilitating capture of industrially-produced weapons	Acquisition facilitates armed conflict, including attacks on civilians and security and military personnel.
States	Limited availability of conventional firearms, circumventing sanctions or embargoes	Acquisition or production may entail the misuse of international aid and can facilitate armed conflict.

Data suggests that the highest concentrations of craft-produced small arms are among individual criminals and criminal groups outside of active conflict zones. In contrast, most non-state armed actors operating in conflict and post-conflict zones possess notable quantities of professionally-manufactured small arms captured from opposing forces or supplied by state sponsors (ARES, 2018). These groups generally decide to engage in craft production of light weapons and light weapons ammunition, which are often less frequently captured (due to the lower quantities in circulation) and more difficult to smuggle in from neighbouring countries (due to size, control measures, and other factors).

Tribal groups and families

In remote regions, tribal groups and families employ improvised and craft-produced firearms, both as part of their culture and as a result of limited alternatives. This is the case among a limited number of groups in Central and South America, Saharan and sub-Saharan Africa, and areas of the Middle East and Asia, such as Pakistan's Khyber Pakhtunkhwa province (Benton, 2008; Okumah, 2014; Sullivan, 1998).

In regions that have experienced prolonged insurgency or civil war, tribal groups are more likely to possess significant numbers of conventionally-produced weapons. Tribal groups in Afghanistan are much better armed than those in rural Nigeria, for example (ARES, 2018). The acquisition of arms through local channels or, in some cases, the provision of arms by counterinsurgent or insurgent forces, may result in a shift away from craft-produced weapons in communities under threat. Some evidence suggests, however, that there is a direct correlation between political turbulence or an increased tempo of violence in a region, and increased demand in improvised and craft-produced arms manufacturing among tribal groups (Hinshaw, 2014). In some areas of Nigeria, individuals buy and build improvised and craft-produced firearms as a direct result of the perception that the government is unable to provide for their protection.[39]

Tribal militias in Nigeria's Borno State make extensive use of improvised and craft-produced weapons, particularly smoothbore firearms, including shotguns.[40] Theirs is indicative of the wider use of such firearms among tribal groups, particularly those in Africa. They use the weapons to hunt, as a deterrent to violent attack, and for self-defence. The firearms themselves are overwhelmingly traditional smoothbore shotguns and hunting weapons that would have been considered obsolete more than a century ago. They form part of tribal traditions and are not effective in combat. In fact, these types of weapons have failed to act as deterrents against even lightly armed insurgent groups in Afghanistan and poachers in sub-Saharan Africa.[41] They are typical of those in use with tribal and family groups in ungoverned spaces around the world (Kilcullen, 2013).

In some cases, tribal groups may manufacture improvised and craft-produced firearms specifically for sale, rather than for use. The areas around Danao in the Philippines

and Darra Adam Khel in Pakistan are particularly well known for this. Workshops in both areas produce semi-professional copies of commercially-available weapons, a reminder that crude smoothbore guns, such as those made in Nigeria or Ghana, are not the only class of weapon produced by tribal groups and families (ARES, 2018).

In regions that are experiencing prolonged armed conflict, tribal groups are often relatively well-armed, as necessity dictates and as weapons become more prevalent in the region. Yet while such groups may employ improvised and craft-produced weapons during the early stages of such a conflict, they tend to transition to commercially-available arms as soon as practicable.

Hobbyists and collectors

A small but nonetheless important demographic is that of hobbyists and collectors. While these individuals are generally unlikely to employ their weapons in support of violent crimes, the manufacture or possession of improvised and craft-produced firearms may be regulated by national legislation (see Section VIII).

In the United States, individual manufacturers and collectors of improvised and craft-produced firearms make up a very small minority of gun owners; their contributions to the understanding of these weapons systems are significant, however. Such hobbyists and collectors often produce and promulgate ideas and designs for improvised and craft-produced weapons—primarily small arms—in discussion forums and social media posts, video hosting and sharing platforms, and elsewhere online (see Image 10). This type of information sharing is undoubtedly useful for researchers and law enforcement, but it may also prove of value to criminals and non-state armed groups, both domestically and abroad. In 2014, for example, a British man constructed a homemade pipe shotgun[42] by following instructions in a YouTube video; the gun was subsequently used to shoot and seriously wound a drug dealer (Osuh, 2014).

Image 10 A still from a YouTube video showing the construction of a .22 pistol

Source: Jenzen-Jones (2017a)

Subsistence poachers

Small-scale poaching groups that operate in remote areas tend to make do with very crude weapons (ARES, 2018). Images of firearms seized from low-level poachers in the south-west of the Central African Republic show precisely such weapons. During a patrol in 2014, for example, guards of the Dzanga–Sangha Protected Area confiscated 11 firearms, 10 of which were craft-produced. These appear to be smoothbore break-barrel and muzzle-loading weapons, which were most likely used to fire improvised projectiles (Demian, 2015). Subsistence poachers, as opposed to commercial poachers, appear more likely to employ improvised and craft-produced firearms.[43]

Despite the increasing militarization of poaching in Africa, many individuals and groups still use crude improvised and craft-produced small arms due to financial and supply constraints. Local blacksmiths in many areas produce cheap and effective smooth-bore guns that fire improvised shot or pointed projectiles intended for hunting larger game, such as elephants and rhinoceroses (Carlson, Dönges, and Wright, 2015; see Image 11).[44]

Improvised and craft-produced weapons are sometimes chambered for conventional hunting calibres popular in Africa, including .308 Winchester, .375 Holland & Holland, and various .416 and .458 calibres (ARES, 2018). Some of these commercial calibres may pose a particular danger when used with improvised and craft-produced firearms, due to the significant chamber pressures they generate.[45]

Image 11 A rhinoceros poacher's craft-produced revolver, fitted with what appears to be an improvised suppressor, recovered in South Africa

Note: The cylinder length and robust steel construction suggest it may be designed to fire a rifle cartridge capable of mortally wounding a rhinoceros.

© Thomas Snitch

Individual criminals and criminal organizations

In comparison to subsistence poachers in remote settings, individual criminals and criminal organizations in urban centres throughout the developing world tend to employ higher-quality craft-produced small arms. Moreover, they are perhaps the most well-documented producers and users of improvised and craft-produced firearms.

Criminal elements are the most significant users in terms of the direct employment of improvised and craft-produced firearms, especially in developing nations.[46] In South America, 20 per cent of firearms seized by provincial police in Buenos Aires in 2014 were described as 'homemade', as were 15 per cent of firearms seized in Minas Gerais, Brazil, in the same year (Instituto Sou da Paz, 2014a; Stampella, 2015). Indonesian police reported in 2013 that '98 percent of the guns confiscated from robbery suspects were home-made and that most of them were made by air rifle makers' (*Jakarta Post*, 2013).

These weapons are also of concern in developed states, including where conventionally-produced firearms are not readily available. According to senior law enforcement and intelligence officials in the United Kingdom, improvised, craft-produced, and converted firearms accounted for approximately 80 per cent of guns used in crimes in 2011 and 2012.[47] In mainland Britain, these weapons include 'pen flare' launchers converted to .22 long-rifle (LR) calibre, slam-fire shotguns, and zip guns, primarily in .22 LR calibre. Very few improvised or craft-produced firearms of higher quality have been recovered, with the exception of limited numbers of 9 × 19 mm sub-machine guns, such as those produced by P.A. Luty.[48] While these weapons are limited in range and accuracy, data collected by UK law enforcement agencies suggests that the majority of guns discharged in criminal acts are employed within ten metres of the target.[49]

In New South Wales, Australia, 'junk guns' accounted for at least 10 per cent of firearms seized during serious crime investigations in 2014 (Harris, 2015; Morri, 2014). The commander of the Sydney Firearms Squad of the New South Wales Police Force, in Australia, reported in the same year that 'lower-end' criminals often use such weapons due to their low price and concealability (Harris, 2015).

Criminal groups also make use of substantial numbers of improvised and craft-produced weapons. From the Italian Mafia and Australian outlaw motorcycle gangs to commercial poachers operating in Malawi, criminal groups routinely supplement their arms holdings with improvised and craft-produced firearms—primarily due to a lack of alternatives. Criminal organizations may also be involved in the illicit trafficking of such weapons, both within and between states (see Box 3).

As discussed below, the ways in which both individual criminals and criminal organizations acquire, produce, and use improvised and craft-produced firearms in developed states differ markedly from how they do so in developing countries.

Criminals in developed states. In many developed states, strict laws aimed at limiting the proliferation of firearms have provoked the use of improvised and craft-produced weapons (*El Nuevo Diario*, 2010; Morri, 2014). In some cases, criminals prefer them to conventionally-manufactured weapons, particularly if they are not able to purchase firearms legally.

In the United States, interest in home-finished weapons has grown due to the anonymity that they afford the user, despite the ready availability of commercial firearms (Van Brocklin, 2015). This anonymity may be equally appealing to individuals with no criminal intent, making such firearms difficult to monitor effectively. The demand for so-called ghost guns—copies of conventional firearms with no serial number—has also been increasing (National Geographic, 2016).

In Italy, organized crime groups have made extensive use of improvised and craft-produced firearms. Many of these illicit weapons are manufactured in the north of the country, around Val Trompia, home to much of the highly concentrated Italian arms industry. The wealth of expertise and manufacturing equipment in the area is exploited by criminal groups, especially those that seek to modify or convert small arms (*NRC Handelsblad*, 2010).

Outlaw motorcycle ('biker') gangs in Australia have also turned to improvised and craft-produced small arms. A significant cache of weapons was recovered in Sydney in 2014, offering insight into the inventory of these groups. Authorities found various craft-produced sub-machine guns chambered for 9 × 19 mm, some of which appear to have been produced using relatively sophisticated manufacturing techniques (ImproGuns, 2014d).

As a result of restrictions on private ownership of some types of functional firearms, Europe has for decades had a market for deactivated souvenir weapons, some of which have been reactivated and sold on to criminal groups (Thain, 2016). Reactivation usually involves removing welds, pins, or barrel obstructions, and replacing components destroyed during the deactivation process, such as barrels, firing pins, and bolts, with 'live' components or improvised alternatives (Ferguson and Jenzen-Jones, 2016; Warlow, 2007).[50] In 2015, the European Union introduced a strict common standard for deactivation, which also prohibits the sale of weapons that have been deactivated in line with superseded, country-specific standards (EU, 2015; 2017). The tightening of restrictions on such weapons may lead some criminal elements to shift their focus away from the reactivation of firearms and towards craft production.

Such restrictions could affect groups such as British gangs, which have demonstrated their ability to reactivate ageing deactivated weapons, often through simple production techniques. In one case, a British gang member sourced more than 40 deactivated small arms and, using expertise acquired during military service, managed to convert (or reactivate) eight of these in a workshop in East London—before being arrested (Thain, 2016). In line with many organized crime groups worldwide, British criminal

groups also employ zip guns, as well as other crudely constructed craft-built firearms and modified or original-purpose antique weapons.[51]

Criminals in developing states. Armed criminal organizations employ much the same techniques as those in the developed world, although improvised and craft production takes place on a larger scale. The manufacture and use of craft-produced firearms is extensive in Latin America, particularly in Brazil, where violent criminal groups play a key role.

Zip guns, slam-fire shotguns, and craft-produced sub-machine guns are prevalent throughout Latin America, although they vary significantly in quality. Vast ungoverned spaces in Brazil, for example, have given rise to a broad range of manufacturing parties and unique design iterations. The relative consistency in production of some of these weapons indicates that skilled, organized craftsmen are operating in remote areas where law enforcement has not been able to disrupt their activities. In May 2002, police in São Paulo raided an illicit workshop with sophisticated metalworking equipment that was manufacturing craft sub-machine guns. The workshop was producing some 50 weapons per month and as many as 600 firearms before being shut down. Each weapon was allegedly sold for about USD 2,500—more than double the market value of higher-quality, legally-produced weapons (Dreyfus, 2002; Lombardi, 2002).

Box 3 Transfers of craft-produced firearms across borders

A number of recognizable craft-produced firearms have been spotted far outside of their country of origin as a result of organized criminal trafficking. For example, a number of sub-machine guns that were first identified as locally produced in Danao, in the Philippines, were recently seized in Mexico. Copies were produced in Mexico after examples had been smuggled in from the Philippines (ARES, 2018).

The South-east Asian illicit market has also drawn customers from nearby Australia, whose strict gun laws and higher incomes lead criminals to pay comparatively high prices for improvised and craft-produced weapons, including those produced abroad (see Image 12). In the Philippines, locally craft-produced sub-machine guns are available for as little as AUD 400 (USD 300). Once the weapons are in Australia, the price jumps to somewhere between AUD 5,000 and AUD 15,000 (USD 3,700–11,200), making trafficking in these arms a highly profitable venture (Pavlovich, 2016). US criminal networks have also reportedly tapped into the market in Danao-made Colt 1911 self-loading pistol copies, as untraceable 'ghost guns' that never had a serial number can command a premium in the United States (National Geographic, 2016).

A significant number of improvised and craft-produced weapons originate in Croatia. An Interpol investigation revealed that 'tens of villages' throughout the Zagorje region were involved in the illegal production of semi-automatic and automatic weapons, including

handguns, sound suppressors, and disguised firearms (*Nacional*, 2003). Image 13 shows a sub-machine gun craft-produced in Croatia; this design was seized in significant numbers from organized criminal groups in various European countries, most notably Italy and the United Kingdom.[52] These firearms are deceptively marked 'Intratec TEC-9', which is inscribed at a near-professional standard. They only bear a cursory resemblance to their namesake, suggesting that the falsified markings serve as a marketing ploy to increase the weapon's credibility and street value, a common trait seen among craft-produced weapons of this standard (ARES, 2018).[53]

Another craft-produced sub-machine gun recently encountered in multiple European countries appears to be built to the same professional standards, utilizing one-piece milled components in the same way as a factory produced self-loading pistol. These pistols are marked with the fictitious company brand name 'R9-ARMS CORP USA', which appears to be professionally laser-etched onto the slide (see Image 14). Upon seizing the weapon, Dutch police consulted the US Bureau of Alcohol, Tobacco, Firearms and Explosives, which indicated that there were no companies with that name in their files (ImproGuns, 2015). The high quality of these firearms suggests that they were produced in a factory with commercial-grade light-engineering capabilities. In July 2015, 14 of these sub-machine guns, along with accompanying sound suppressors and laser modules, were seized with assault rifles, hand grenades, and high explosives in a Croatian police operation targeting suspected weapons trafficking groups (Tomašković, 2015).

Image 12 A copy of the Cobray/Ingram .380 M11, marked 'Cobray', made in Danao and seized in Australia in March 2015

© Australian Federal Police

Image 13 A sub-machine gun spuriously marked 'Intratec TEC-9', seized in the United Kingdom

© Jonathan Ferguson/ARES, courtesy of the National Firearms Centre/Royal Armouries

Image 14 An example of an illicitly produced 'R9-ARMS' sub-machine gun seized in Western Europe

Note: Probably of Croatian origin, it is fitted with a commercially-available laser module intended for use on the Umarex/Walther CP99 replica air pistol.
© Firearm Blog

In August 2016, police in Minas Gerais, in south-eastern Brazil, raided an illicit workshop that was producing crude sub-machine guns. Each of these was sold to buyers for about USD 1,125 via the messenger application WhatsApp. Weapons manufactured in this factory continue to be widely seized in and outside of the state (ARES, 2018). In June 2017, an illicit workshop producing sub-machine guns operating in the Brazilian state of Santa Catarina was raided following the discovery of an ecstasy lab operated by the same group. A police investigator noted that each weapon had been sold for about USD 4,000—roughly double the price of similar, conventionally-produced weapons. He remarked that clandestine weapons were more expensive because of their easy accessibility and because there were no restrictions on clandestine sales (RBS TV, 2017).

Insurgent groups and militias

As is the case with the majority of groups that use improvised and craft-produced weapons, insurgents and militias most commonly employ them to fill a capability gap, while maintaining a preference for professionally-manufactured equipment. Unlike many armed criminal groups, which supplement original-purpose small arms with improvised and craft-produced examples, insurgent and militia groups often have an abundance of

Image 15 Syrian opposition fighters with a craft-produced mortar tube and a projectile in Aleppo, Syria, on 18 February 2013

© Hamid Khatib/Reuters

serviceable, professionally-manufactured small arms and tend to turn to craft production for light weapons. Their acquisition patterns tend to reflect the availability of conventional weapons within a country, including those supplied by external actors during ongoing conflicts. Entities as varied as the non-state armed group Islamic State, Hamas, the Revolutionary Armed Forces of Colombia (Fuerzas Armadas Revolucionarias de Colombia, FARC), and dissident Irish Republican militants have all produced light weapons and used them in conflict (ARES, 2018). Specific examples are discussed in Section VI.

Insurgents and militias may also find themselves in need of ammunition for light weapons, including grenade launchers, mortars, and recoilless guns. When supplies are limited, craft-produced alternatives may be employed. Non-state actors sometimes even develop near-industrial-scale manufacturing capabilities to produce much-needed ammunition. Islamic State forces have manufactured improvised rocket-assisted munitions, mortar projectiles, and other munitions on a quasi-industrial scale, for example (ARES, 2018; CAR, 2016).

Improvised mortar projectiles are fairly common in the Middle East and North Africa, where they are manufactured and employed by armed groups across the ideological spectrum (see Image 15). The various armed Irish Republican groups have also employed craft-produced materiel throughout their collective history. Unlike some other groups, the Provisional IRA had restricted access to small arms as well as light weapons; it was therefore motivated to craft-produce quantities of both to supplement stocks of commercial firearms. In several cases, non-state armed actors have assisted one another in developing improvised or craft-produced small arms and light weapons (see Box 4).

Image 16 A FARC-made mortar projectile reminiscent of those fired from the original Provisional IRA Mark-14 model, photographed in 2015

Note: The munition contained approximately 25 kilos of ANFO (ammonium nitrate/fuel oil) explosive composition.

© Ejército Nacional de Colombia

Box 4 FARC–Provisional IRA cooperation in Colombia

The guerrilla group FARC employed a range of craft-produced and improvised weapons against Colombian government forces, paramilitary groups, and civilians. While the FARC did use a limited number of craft-produced small arms,[54] it was most effective at manufacturing and employing improvised and craft-produced light weapons, primarily improvised mortars and recoilless guns.

Like non-state armed groups in the Middle East and North Africa, the FARC employed craft-produced light weapons because their professionally-manufactured counterparts were difficult and costly to acquire.[55] In contrast, the materials needed for manufacture were cheap, readily available, and not incriminating in themselves. Further, the resulting improvised systems themselves—such as mortars and other bulky weapons—were cheap and therefore expendable.

Through extensive training by former Provisional Irish Republican militants between 1998 and 2001, the FARC was able to upgrade its use of improvised light weapons and explosive devices (Chalk et al., 2007). In the words of the former Colombian vice-minister of defence, Andres Peñate:

> The IRA provided the FARC with a quantum leap in their use of explosives. Basically we saw an improvement in their homemade mortars, making them more accurate. Also we saw an improvement in their ability to arm car bombs, which were not so common before (McDermott, 2007).

In manufacturing improvised mortar designs, the FARC almost precisely replicated earlier Provisional IRA weapons (see Image 16). The guerrilla group also adopted Provisional IRA tactics, techniques, and procedures, such as abandoning a fired weapon if the situation dictated, to allow for a swift escape at minimal economic and logistical cost, or using weapons that could be fired remotely, to maximize the guerrillas' safety during operations (ARES, 2016; Chalk et al., 2007).

Provisional IRA forces also benefited from the cooperation, since the Colombian jungle served as a convenient sanctuary. As noted in a security assessment provided to the BBC in 2002:

> PIRA (Provisional IRA) have been using Colombia as a training ground to carry out tests with their engineering department as they are no longer able to use the Irish Republic due to the current political climate (Rowan, 2002).

In December 2004, a superior court in Colombia convicted three Irish Republicans and sentenced them to 17 years in prison for training guerrillas (BBC, 2005). The following year, Carlos Ospina, the general commander of the military forces of Colombia from 2004–07, said there was no doubt that FARC forcers had employed Provisional IRA techniques during a February 2005 counter-offensive (McDermott, 2005).

States

States and territories that are under an arms embargo or sanctions regime may perceive a need for improvised and craft-produced firearms. It is otherwise unusual for states to engage in craft production, which is generally inefficient in comparison to more conventional methods of manufacture. States tend to differ from other types of users in that they enjoy robust access to materials, skilled labour, and tooling, and are thus able to craft produce weapons on a near-industrial scale. An entity under embargo that receives international aid may be able to repurpose industrial materials intended for use in infrastructure projects in the craft manufacture of weapons. A good example of such repurposing is the manufacture of various Qassam rockets in Gaza by Hamas (Fighel, 2005a; 2005b; Richardson, 2002).

During formative periods, new states often incorporate local production of relatively crude weapons into their arms acquisition planning. During the 1991 Croatian war of independence, for example, a model of a simple sub-machine gun known as the Zagi M-91 was produced (ARES, 2015). Following independence, this firearm was incorporated into the armouries of Croatian police units and other forces. Similar weapons have been produced and used in other states, such as Israel. Improvised air-delivered munitions have also been used by state forces in recent years. Notable examples include the Syrian government's use of improvised munitions to disperse industrial chlorine in a number of incidents, and the use of small, improvised air-delivered munitions by Iraqi government forces in conjunction with commercially-available unmanned aerial vehicles (UAVs) (see Box 5).

State and quasi-state[56] forces may adopt improvised and craft-produced weapons if they cannot acquire sufficient numbers of industrially-produced firearms. In Nigeria, for example, some wildlife rangers at national parks make use of craft-produced 'Dane guns' to supplement conventional shotguns (Findlay, 2016; WCS, 2017).[57]

“Improvised ammunition ranges from safe and reliable to decidedly unsafe and unreliable.”

V. Small-calibre ammunition for craft-produced firearms

Commercially-available ammunition

Mass-produced ammunition is legally available on the civilian market in many countries, including those with strict permits for acquisition in place. In particular, .22 LR and various shotgun cartridges are popular for sports shooting purposes the world over; they are often more readily accessible than centrefire rifle and handgun cartridges (Jenzen-Jones, 2017b). As a result, organized criminal and terrorist groups have made consistent use of them, including in improvised and craft-produced firearms. Since .22 LR and shotgun cartridges generate relatively low chamber pressures when fired, they are ideal for use in improvised and craft-produced firearms, which tend to have low manufacturing tolerances and inferior material quality (Hays and Jenzen-Jones, 2016).

Other types of small-calibre ammunition are widely available to many non-state armed groups through different supply chains, including stockpiles captured from legitimate end users (ARES, 2018). State collapse is also associated with the proliferation of industrially-manufactured ammunition, especially in the world's conflict zones. Since the fall of the Iron Curtain in 1991, ammunition in common military calibres and loadings has been prolific in much of the former Soviet territory. Similarly, in the wake of the 'Arab Spring', large quantities of ammunition flooded the illicit market; some of it was no doubt acquired for use in improvised and craft-produced weapons (ARES, 2018). In other cases, retreating or withdrawing forces have left behind significant quantities of military ammunition, as was the case when Iraqi troops withdrew in the face of early Islamic State advances (Amnesty International, 2015).

Improvised small-calibre ammunition

When conventional ammunition or reloading components are unavailable or scarce, alternatives may be improvised from scratch or adapted from other cartridge types. Local users in developing nations use various crude ways to reload fired cartridge cases. As discussed below, the fired primers[58] of centrefire cartridge cases are sometimes reused with match heads, small percussion caps from children's toys, or other impact-sensitive mixtures that can replace original priming compounds and provide reasonably reliable ignition sources. A propellant charge, whether loaded into a cartridge case or directly into a muzzle-loading firearm, can be improvised, while projectiles—especially shot—can easily be cast from lead or other metals.

Improvised ammunition ranges from safe and reliable to decidedly unsafe and unreliable. When used with self-loading firearms, in particular, crudely improvised ammunition may present feeding and cycling issues, whereas it may function quite reliably in single-shot weapons. Safety issues can also arise when the potency of improvised propellant is unknown, or the amount of propellant used is not consistent.

Image 17 A man in the Philippines uses match heads in place of commercial propellant to load and prime an improvised muzzle-loading shotgun

© MSL Bushcraft via YouTube

Propellant may be improvised from a variety of materials, such as the heads of certain matches;[59] alternatively, black powder may be prepared using simple production methods (Jenzen-Jones, 2017a; 2018). Matches are often readily available in areas where conventional black powder or other commercial propellants may not be (see Image 17). The use of match heads and other unconventional propellants may result in a failure-to-fire, hang fire issues,[60] or other concerns.

Projectiles may be improvised in different ways (see Image 18). They may be cast from lead, or turned from steel, brass, or other metals. Groups in Papua New Guinea have even melted down bronze memorial plaques for this purpose (Koorey, 2016). In some cases, conventional projectiles are melted and re-formed into the desired configuration (Nchanji, 2005). Crude 'penetrators' may be fashioned from steel and coated with lead to reach the appropriate bore size; readily-available materials such as ball bearings, reinforcement bar, and ceramic spheres may be employed. Blank ammunition used for signalling and in powder-actuated nail guns is often modified with the addition of a projectile to create an alternative to .22 LR cartridges (see Images 19 and 20).

Image 18 A variety of improvised or converted designs for lethal-purpose ammunition seized by British law enforcement at different times

Source: © Jonathan Ferguson/ARES

Image 19 Improvised ammunition made from 7.62 × 39 mm cartridge cases modified to accept 6.8 mm Hilti powder-actuated tool cartridges in place of a primer and loaded with a projectile turned from brass bar. This hybrid ammunition is designed for use in an improvised 'sub-machine gun'

Source: Jenzen-Jones (2017a)

Image 20 Improvised ammunition made by modifying conventional cartridge cases, signal blanks, and charges used by powder-actuated tool cartridges

Source: EkoCzao

In developing nations, shotshells are commonly reloaded with locally-produced lead shot. The lead is typically recovered from existing, discarded sources, such as battery cells, and may be poured into moulds. It can also be gravity-formed, meaning that molten lead is poured from atop a tall tree or building into a container or body of water below.[61] Wadding for shotshells may be improvised from scraps of discarded fabric, felt, rubber, or other materials. Discarded sandals are a popular source of wadding material in parts of Nigeria, for example (Y-man, 2013a; 2013b).

“Some craft-produced firearms are disguised as innocuous-looking items that can pass unnoticed during a cursory inspection.”

VI. Improvised and craft-produced small arms

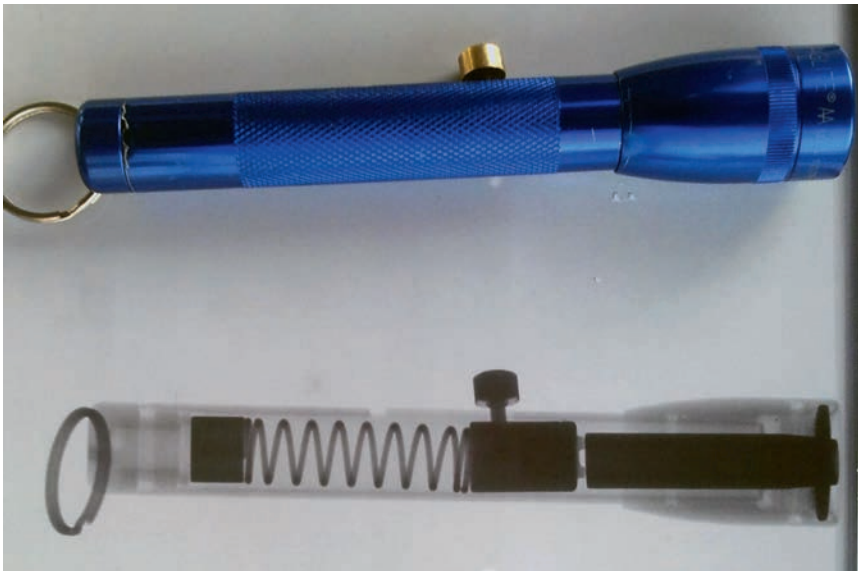
Disguised and adapted firearms

Some craft-produced firearms are disguised as innocuous-looking items that can pass unnoticed during a cursory inspection. Various everyday items, from writing pens to torches and mobile phones, have been adapted to shroud small, improvised firing mechanisms.

A typical homemade pen gun consists of a tubular body that houses a spring-loaded striker and a screw-on barrel, sometimes tapered to replicate the writing end of a large pen. Such a pen is often identifiable by an unusually-large hole where the nib should reside and the presence of unusual external protrusions. Some pen guns resemble genuine writing pens in every way, including a functioning writing nib and hidden trigger, usually disguised as a pocket clip. More sophisticated firing mechanisms may function like a firearm striker, one that is compressed and released when the two halves of the 'pen' are clicked together.

Firearms disguised as electric torches (flashlights) are often adapted from genuine Mini Maglite flashlights (see Image 21). In these weapons, the bulb housing is sleeved down to hold a short length of tube that acts as a barrel and that can be screwed on or off to load a cartridge. A 'bolt' with a fixed firing pin is actuated by a strong compression

Image 21 An X-ray image of a Mini Maglite flashlight adapted to function as a .22 calibre zip gun



© Maddened Fowl Blog

Image 22 A staple gun adapted to fire .22 LR ammunition, with the addition of a length of tubing for a barrel

© California Department of Corrections and Rehabilitation

spring. Such weapons are typically manipulated and fired by either an external cocking handle attached to the striker assembly or a rod extending out of the rear with a pull-ring attached.

Conveniently for would-be gunsmiths, some available items already contain a strong spring-loaded mechanism of one sort or another, offering considerable scope for adaptation. Industrial nail guns and household staple guns are both commonly adapted for use in improvised firearms. Staple guns are generally modified by the attachment of a chamber or barrel in the form of a section of steel tube or car brake line in front of the striking surface (see Image 22). Some crude weapons made in this manner have been chambered for fairly potent rifle and shotgun rounds, sometimes with multiple revolving barrels added (ARES, 2018). These weapons are generally distinguished from zip guns based on the presence of a more conventional type of trigger mechanism; the principles of their design remain very similar, however.

Items that are ordinarily powered by blank cartridges—that is, cartridges containing propellant but no projectile, designed solely to generate gas pressure for other purposes—

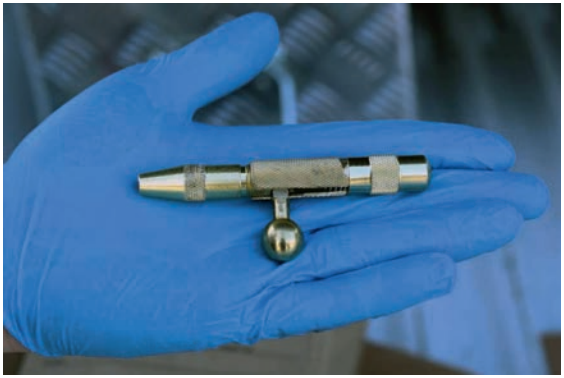
have also been converted into improvised firearms. It is not unusual for powder-actuated nail guns, which are used to drive nails into hard materials such as concrete, to be adapted to work as firearms, particularly in China (Guangxi News, 2015). In their modified state, safety mechanisms are generally disabled and a length of steel tubing is fitted in front of the chamber to act as a barrel. A projectile or shot is loaded in front of a blank cartridge. Such weapons are often seized during poaching-related arrests in China (Nujiang, 2011).

Zip guns

Although there is no established definition, a zip gun[62] is generally understood to be an improvised, single-shot, small-calibre firearm that lacks a conventional trigger mechanism. Originally, weapons referred to as 'zip guns' were true improvised firearms hastily cobbled together by youths using nothing more than a hacksaw; most of them were hazardous to the user. Perhaps the simplest variation of zip guns began turning up in New York City in large numbers during the 1950s and 1960s (Koffler, 1969).

What unites weapons in this category is the lack of a conventional trigger mechanism. Instead, some examples incorporate a length of metal tube to house a barrel and a striker or firing pin with a spring behind it. These weapons are loaded by inserting a cartridge through a loading port cut into the tube; they are fired when the striker is pulled back and released. Sometimes the length of steel tubing happens to be of the correct inner diameter; other examples feature a length of car brake line or another substitute material. In several cases, the steel tubing is reinforced in some way, such as through tight wrapping in piano wire (Jenzen-Jones, 2017a; Van Pelt, 2018; n.d.).[63]

Image 23 A .22 LR calibre zip gun made from a USD 2.50 centre punch tool (selling price: 80 USD)



© New South Wales Police

Image 24 A crude zip gun built to resemble a bolt-action rifle, complete with a non-functional trigger and mock wooden magazine

Note: This weapon was surrendered by a Kikuyu gunsmith who called himself General Doctor Russia in 1956, as part of an amnesty during the Kenya Emergency.

© Imperial War Museums

Alternatively, such firearms may be based around repurposed mechanisms, such as a centre-punch (see Image 23).

These weapons most often employ .22 LR calibre ammunition, as cartridges generating higher gas pressures may prove (more) dangerous in an unsupported breech. Many zip guns are damaged beyond use after one or a handful of firings (Jenzen-Jones, 2017a). Given that plans for their construction are widely available online, that acquiring the necessary components is uncomplicated, and that they are easy to use, zip guns continue to be produced and employed throughout the world.

Crude variations on the basic zip gun can involve fabricating or repurposing a grip and attaching a spring-loaded hammer, which is pulled back and released with the thumb to fire a cartridge. If a sturdy pivoting barrel or screw-in breech is incorporated, rifle and shotgun ammunition may be used in the same manner as detailed in US Army publications, with relative safety. One of the crudest methods of construction, used since the earliest days of the zip gun, involves taping a short section of steel tube, sometimes car antenna or brake line, in place of toy cap gun's barrel (Jenzen-Jones, 2017a; Van Pelt, 2018). The hammer is then modified and elastic bands are used to increase the force applied to the rim of a small rimfire cartridge. In some cases, stocks may be built around zip guns so that they take the form of long arms, rather than handguns (see Image 24).

Shotguns and smoothbore muzzle-loading guns

Smoothbore shoulder weapons may comprise little more than steel pipe mounted on rudimentary wooden furniture. Generally either break-barrel or muzzle-loading designs, they are routinely encountered in rural West Africa (ARES, 2018; Findlay, 2016). Ghana,

which has no officially regulated arms industry, is home to many traditional producers of relatively poor-quality craft smoothbore weapons (Batchelor, 2003). Despite the militarization of poaching in recent years, many small-scale poaching groups still employ traditional smoothbore hunting weapons (Carlson, Dönges, and Wright, 2015; Findlay, 2016).

Slam-fire and other improvised shotguns are also prolific among criminal groups throughout the world (ARES, 2018). Their ease of construction, together with the accessibility of their parts, makes them ideal weapons for those who cannot afford more sophisticated weapons, be they poachers or low-level criminal groups.[64] Pistols chambered for shotgun cartridges are also common, as discussed below.

Slam-fire pipe shotguns

Among the most frequently encountered improvised firearms, the simplest and most effective may be the 'slam-fire' shotgun, also known as the Four Winds Shotgun, pipe shotgun, *paltik*, *paliuntod, sumpak*, and *tumbera* (see Image 25). This design calls for

Image 25 A slam-fire shotgun (top) and an improvised striker-fired break-barrel shotgun (bottom)

© Jonathan Ferguson/ARES, courtesy of the National Firearms Centre/Royal Armouries

readily-available steel tube and, in its most basic form, requires no tools and almost no skill to assemble. The 'barrel' usually consists of a length of steel pipe with the correct inner dimensions to chamber a 12-gauge shotgun cartridge. This piece is sheathed inside a shorter length of pipe with an end cap affixed. A fixed firing pin is attached via any of several methods (Jenzen-Jones, 2017a). The weapon is fired when the 'barrel' is pulled rearward towards the user, which causes the primer of the chambered cartridge to contact the firing pin. This movement is sometimes referred to as a 'trombone action' (Shea, 2007). These shotguns can be easily disassembled or discarded, with little probability that their components will be recognized as any sort of weapon.

Other variations in construction include the welded addition of a piece of steel with a nail affixed to form a breech, as well as the use of bicycle and even bed frames as a source of material. These weapons are so simple to produce that they were even manufactured by Ulster Volunteer Force inmates inside Maze prison, in Northern Ireland. Four examples were produced from tubular basketball stanchions and bed legs (Smith, 2014). Some of these shotguns feature multiple barrels, others are scaled down to accept rimmed pistol or rifle cartridges. Due to the relatively low pressures generated by shotgun cartridges and a typically oversized bore, these weapons are generally safe to fire, which explains their appeal among hobbyists as well as criminals.

Traditional smoothbore hunting weapons

Tribal groups around the globe manufacture and use craft-produced muzzle-loading weapons and single-shot shotguns. These groups may be granted special exemptions from restrictions on possession of these weapons from national governments. The Miao people of southern China, for example, are permitted to manufacture and use traditional muzzle-loading pistols and long guns for cultural displays of marksmanship, which they often perform for tourists. The spillover of arms-manufacturing skills into neighbouring regions has led individuals who are not ethnic Miao to produce and keep identical weapons illegally, as was highlighted in 2016, when authorities seized and destroyed large quantities of guns in front of the media (Guangxi News, 2016). At their most basic, crude muzzle-loading weapons consist of a makeshift barrel with a touch-hole for ignition of powder, affixed to a crude handle or stock (see Image 26).

Although single-shot long guns are not typically seen as weapons of warfare, traditional hunters in the Nigerian state of Borno have openly displayed them to show their willingness to participate in the fight against Boko Haram militants. These weapons are generally percussion-lock ('caplock') muzzleloaders and break-action shotguns with crudely crafted wooden stocks and barrels that are frequently made from water pipe (ARES, 2018).

Many muzzle-loading weapons produced in Nigeria, Ghana, and elsewhere are known as 'Daneguns' or 'Dane guns' and are based on 19th-century European percussion rifle

Image 26 An especially crude muzzle-loading handgun featuring a barrel crafted from a 20 mm cannon cartridge case

Note: The weapon is fired when a match is touched to the hole towards the top rear of the case. British forces seized this weapon during the 1955–59 Cyprus Emergency.

© Jonathan Ferguson/ARES, courtesy of the National Firearms Centre/Royal Armouries

patterns (Christopherson, 1975, p. 210).[65] These firearms tend to feature carved, unfinished stocks, as well as locks fashioned from locally-sourced scrap metal (ARES, 2018; see Image 27).[66] The barrels on some of these weapons are made from repurposed motorcycle suspension forks or automobile steering arms (Nchanji, 2005). A skilled craftsman is typically able to make several of these firearms per day from readily-available, locally-sourced material (Batchelor, 2003).

Image 27 A crude hand-made percussion lock mechanism fitted to a muzzle-loading 'Dane gun' produced in Plateau State, Nigeria, August 2017

© Small Arms Survey

As discussed in Section V, ammunition—shot, propellant, and wadding—for these weapons is also improvised using a number of primitive techniques. When manufactured percussion caps cannot be obtained, improvised substitutes are sometimes created from impact-sensitive paper caps for toy guns.

Between 2012 and 2014, following attacks by Boko Haram, prices of locally-made guns in parts of Nigeria reportedly jumped from around USD 30 to USD 50; meanwhile, industrially-made imported shotguns fetched around USD 175 (ARES, 2018; Hinshaw, 2014). These types of weapons are frequently recovered from poachers in several West African countries, including Cameroon and Nigeria (Nchanji, 2005; WCS, 2017; 2018).

Handguns

Single-shot pistols

In a number of countries, local blacksmiths, gunsmiths, and engineers produce single-shot weapons for sale to consumers who are looking for a cheap, disposable weapon. Such weapons primarily fill a void in the market, serving as cheap substitutes for factory-made handguns (or sawn-off long guns), which are frequently too expensive to obtain either legally or illegally. These handguns are most commonly chambered for locally-available cartridges used for hunting; they are almost invariably based around a conventional break-barrel, hammer-fired design similar to some simple industrially-made firearms. Such designs are common around the world, with numerous examples recovered in Brazil, Colombia, Ecuador, Egypt, India, and Thailand (ARES, 2018; see Image 28). In several countries, consumers purchase such simple weapons—particularly those chambered for 12-gauge shotgun cartridges—to protect themselves against carjacking.[67]

Image 28 A craft-produced double-barrel, break-action handgun produced in Colombia

Note: A half-disc wheel is mounted to the hammer, which can be rotated to allow the user to fire each barrel individually or both simultaneously.

© Colombian Federal Police

Image 29 Three .315 bore *desi katta* or *tamancha* single-shot pistols

© Forensic Science Laboratory, New Delhi

In India, a locally-manufactured single-shot pistol is commonly known as a *desi katta*[68] or *tamancha* (see Image 29). Hotspots for illicit manufacturing have been identified in the Uttar Pradesh and Bihar regions, particularly in the city of Munger. These weapons are typically chambered for rifle cartridges that are widely available in India, including 8 × 50R mm Mannlicher (known locally as '.315 bore') and 7.92 × 33 mm Kurz ('.44 bore') (ARES, 2018). Based on its examinations, the Forensic Science Laboratory in Delhi found that examples chambered for such potent cartridges usually have oversized bores, which reduce chamber pressures and therefore mitigate the stresses applied to the materials used (Waghmare et al., 2012). Were this not the case, recoil would be severe, and the weapon could suffer catastrophic failure upon firing.

In Egypt, craft-produced 12-gauge shotgun pistols locally known as a *fard*, *fard kartush*, or *marotta* are typically made by local engineers using water pipe and other readily-available scrap metal (Elmeshad, 2011). These usually follow the same design patterns and share design features with antique shotguns and signal pistols. They remain the most affordable options, typically costing around one-twentieth the price of a factory-made firearm (ARES, 2018). Before the 2011 revolution, a single-shot *fard* pistol could be bought for EGP 300–500 (USD 50–150); since then, demand has grown in response to rising crime rates, causing prices to rise as high as EGP 1,000 (USD 300) (ARES, 2018; Elmeshad, 2011).

Single-shot pistols with triggers

Although their construction is similar to that of typical zip guns, improvised single-shot pistols that feature triggers and pistol grips look and function somewhat more like conventional firearms. The bolt of such a pistol is cocked and held back on the trigger (usually by a single 'hook' piece) until it is pulled, firing the weapon. In recent years, this method of construction has become more common, probably because the

design is the subject of various popular do-it-yourself online videos, some of which have been viewed more than one million times (Cámara, 2016; Jenzen-Jones, 2017a). Crude single-shot pistols may leave evidence of their design on fired cartridge cases. Excessive bulging at the base of a fired cartridge case indicates that it may have been fired from an improvised weapon with an open or otherwise inadequately supported breech.

Revolvers and pepperbox-type pistols

Craft-produced revolvers and pepperbox-type pistols are encountered less frequently than self-loading or even break-action designs. Copying a conventional factory-produced revolver design by hand requires a relatively high degree of skill and experience due to intricacies involved in the action's timing. Nonetheless, most modern revolver designs are based on 19th-century manufacturing techniques, and copies have been produced in small workshops since the introduction of revolving firearms. Gunsmiths in Colombia, Ecuador, Pakistan, the Philippines, and elsewhere produce high-quality craft copies of modern double-action revolvers (ARES, 2018). Smith & Wesson .38 Special models are among the most commonly copied, particularly the Model 10 and its later small-framed, snub-nosed variants (ARES, 2018; Boyechin, 2000; see Image 30).

Unlike revolvers—in which the cylinder of the weapon rotates ('revolves') with each trigger pull to position a cartridge into alignment with the barrel to be fired—craft-produced handguns of a 'pepperbox' design feature multiple barrels, each with its own chamber. The barrels are manually rotated to align with a single firing pin and hammer (ARES, 2017). Some of these pepperbox-type firearms appear very crude, yet they allow the

Image 30 A craft-produced copy of a Smith & Wesson J-frame snub-nosed revolver, probably produced in Pakistan

© Moscow Criminal Investigations Department

Image 31 A pepperbox-type craft-produced handgun

© Jonathan Ferguson/ARES, courtesy of the National Firearms Centre/Royal Armouries

Image 32 A crude double-barrel .22 LR derringer recovered by police from alleged criminals in South Australia, 2017

© South Australia Police

user to fire anywhere from three to 15 or more shots successively without reloading (see Image 31).

While the term 'pepperbox' is most commonly applied to firearms with three or more barrels, it can also be used to refer to improvised and craft-produced firearms with a rotating two-barrel assembly. Often these are diminutive 'derringer' types, designed to be concealed with ease. In late 2017, police found a simple derringer-type improvised pistol during a raid in Whyalla Stuart, South Australia (*Advertiser*, 2017). This firearm is somewhere between a zip gun (as it lacks a conventional trigger mechanism) and a pepperbox-type pistol (see Image 32).

Self-loading pistols

Local gunsmiths produce self-loading pistols in numerous countries, including China, Colombia, Ecuador, India, Pakistan, the Philippines, and Thailand (ARES, 2018; Hu, 2010). Those who manufacture high-quality examples—especially copies of well-known brands and models—tend to be skilled local artisans. They are able to sell their pistols for a substantial profit, often to individuals who acquire them for personal protection or for

Image 33 A simple .25 ACP self-loading pistol constructed primarily from sheet metal, according to plans widely available online

© Clinton Westwood

criminal activities. Almost all examples are copies of relatively simple direct-blowback action pistols; they often feature frames and even slides constructed primarily from sheet metal, a technique suited to hand manufacture as it does not require the use of heavy machinery (ARES, 2018; see Image 33). Some copies of industrially-produced firearms are very close to their archetypes indeed, sometimes even bearing replicated markings. To the non-specialist, some of these pistols may appear indistinguishable from the originals (see Image 34).

In fairly primitive home workshops and small facilities in the city of Danao, in the Philippines, gunsmiths illicitly produce close copies of popular pistols, such as the Colt Model 1911. At first glance, some guns produced in Danao are superficially indistinguishable from the original designs, and the high volume produced has helped to create a global market for such weapons (Oreta, 2011). In India, gunsmiths have manufactured such a large number of self-loading pistols that they have begun to replace the cheap, single-shot *desi katta* pistols as the concealable weapon of choice in some

Image 34 A very close copy of the Soviet Pistolet Makarova (PM) self-loading pistol, produced in Pakistan

© Jonathan Ferguson/ARES, courtesy of the National Firearms Centre/Royal Armouries

areas (Joshi, 2015). These are usually chambered for the .32 ACP cartridge, and most documented examples appear to be based on a common local pattern (ARES, 2018).

In China, the Songtao Miao Autonomous County in Guizhou province is known for the illicit production of handmade self-loading pistols. The area's complex terrain and significant distance from nearby population centres makes law enforcement difficult, allowing these weapons to proliferate widely throughout the region. Locally-made pistols are sometimes superficially styled after Chinese patterns—specifically the Type 64, whose exterior is modelled on the Walther PPK, and the Type 77. These pistols are trafficked through Xiushan and Huayuan and on to awaiting buyers in coastal cities, where the highest prices are commanded. An experienced gunsmith can assemble a Type 64-pattern handgun in only two or three days and can sell it for CNY 300 (USD 45). After a few more downstream transactions, the same pistol may cost as much as CNY 10,000 (USD 1,500) in large economic hubs such as Shenzhen—a markup of more than 3,200 per cent (ARES, 2018; Hu, 2010).

Underground artisan gunsmiths in a number of Latin American countries are capable of producing self-loading pistols and revolvers of reasonable quality. Reports indicate that in Ecuador, most civilian-held firearms are locally craft-produced. Although unlicensed manufacture of firearms has been prohibited since February 2012, skilled local gunsmiths continue to produce firearms illegally. Private security companies purchase many of these weapons, including self-loading pistols, a large number of which appear to be constructed primarily from sheet metal (*El Telégrafo*, 2013).

Sub-machine guns

Sub-machine guns are perhaps the most widely documented craft-produced small arms in circulation (ARES, 2018; ImproGuns, n.d.). Their high rate of fire and low cost make them attractive to organized criminal groups. Often chambered for the common 9 × 19 mm cartridge, they are frequently based on Second World War or cold war designs, such as the British Sten and the US M3 'grease gun'. As such, they almost always operate on the simple blowback[69] principle, firing from an open bolt (ARES, 2018; Jenzen-Jones, 2017a). Pulling the trigger releases not the firing pin but the entire bolt, which picks up a cartridge from the magazine, chambers it, and fires it by means of a fixed firing pin. The bolt is then 'blown' backward by the fired cartridge, such that the empty case is extracted and ejected, while the bolt is returned to the rear, where it is ready for the next shot. These weapons require none of the complex machining and engineering needed to create a reliably functioning locked-breech firearm, and they can be relatively safe to operate.

A typical craft-produced sub-machine gun is constructed using steel tubing for its receiver. Such tubing, whether round or square in cross-section, is often readily available,

eliminating the need for the complex metalworking operations once required to produce a milled or stamped weapon, such as the Thompson or M3 'grease gun'. A simple one- or two-piece trigger mechanism is sometimes cut from steel plate using home power tools and attached in separate housing to form the fire-control group. This unit is affixed to the main receiver tube using either simple screws or bolts, or somewhat more technically demanding brazing or welding. A smoothbore barrel can be turned from steel bar stock; alternatively, suitable hydraulic seamless steel tubing may be used. Gunsmiths who are able to obtain pre-rifled barrel blanks can substantially increase the potential effectiveness of the finished weapon. The bolt of the weapon is generally either milled as a single piece or laminated together from various size lengths of steel tubing. The use of tubing with a square cross-section (and therefore bar stock for the corresponding bolt) may expedite the precision machining of otherwise complex features.

In view of the difficulties inherent in producing reliably functioning magazines, gunsmiths generally prefer to use commercially-available examples, although some employ homemade ones fabricated from folded sheet steel or rectangular tubing (Forgotten Weapons, 2017). As discussed below, loyalist paramilitaries in Northern Ireland consistently employed British Sterling magazines in the production of sub-machine guns (Shea, 2007). It is no coincidence that magazines, which are freely available in the rest of the UK, constitute a legally-controlled 'component part' under Northern Irish law (Northern Ireland Office, 2005; PSNI, n.d.).

While craft-produced sub-machine guns are simple in design and construction, many lower-quality examples suffer from problems that may impede their function. Poorly made improvised magazines, in particular, are likely to cause feed problems. The angle of presentation of a cartridge relative to the chamber is critical for reliable feeding, as is a sufficiently strong spring and a follower that does not excessively tilt as it moves within the magazine body. For this reason, homemade magazines are generally limited to a single-stack design, rendering them of lower capacity than industrially-made 'double-stack' examples. A typical lack of rifling or even precision deep-hole drilling in barrels results in poor accuracy and very limited effective range, as does inadequate sighting and stock arrangements. Many craft-produced sub-machine guns lack sights altogether, and shoulder stocks are frequently omitted (ARES, 2018; Jenzen-Jones, 2017a).[70]

Despite these technical limitations, craft-produced sub-machine guns have proliferated widely among criminals in many countries, mainly due to the simplicity of their manufacture, their high rate of fire, and no doubt a lack of discernment and small arms training among their users.[71] They may be effective relative to other craft-produced weapons, but the majority are technically inferior to their professionally-produced counterparts.

The barrels of craft-produced sub-machine guns are usually very short and are rarely rifled; nevertheless, their high rate of fire means that they are still effective when employed at close range in urban environments or in close terrain operations. Manufactured using

readily-available materials that are unlikely to raise suspicion when purchased, craft-produced sub-machine guns are only somewhat more time-consuming and costly to produce than single-shot weapons. Their ammunition[72] is also readily available throughout most of the world, as firearms of the same calibres are in service with almost every military or police force. As a result, insurgents, terrorists, and organized criminals can usually access such ammunition. Even when ammunition is scarce, relatively skilled individuals can manufacture it fairly easily.[73]

Northern Ireland

Throughout the 'Troubles' in Northern Ireland, loyalist paramilitary organizations[74] manufactured a large number of homemade sub-machine guns and used them in many attacks. Unlike the Provisional IRA and its successor factions, which had the necessary support and contacts to smuggle conventional arms from overseas into Ireland and Northern Ireland, loyalist groups were largely forced to depend on craft production by their members, many of whom were industrial workers skilled in light fabrication. These members manufactured weapons in dockyards and factories to supplement the loyalists' caches of captured or stolen arms.

Many early examples were copies of the British Sten or Sterling series sub-machine guns, usually produced utilizing spare internal components stolen from army bases and combining them with homemade receivers. In particular, industrially-produced magazines were in high demand, as craft-produced magazines are often unreliable (Forgotten Weapons, 2017). Other guns were produced entirely from scratch. Nicknamed 'rattlers' or 'shipyard specials', they usually had homemade, smoothbore pipe barrels (*Balaclava Street*, 2014; Moss, 2016).

In 1988, police uncovered a unionist workshop in County Down that was reportedly the largest illegal arms factory operating in Northern Ireland at the time. Thirty assembled sub-machine guns were recovered, along with materials sufficient to produce hundreds more. Also seized were craft-produced sub-machine guns copied from the Israeli Uzi design, whose manufacture involved copying the internal components of a Japanese 'plug-fire cap' (aka 'modelgun') replica.[75] The workshop's owner allegedly supplied loyalist paramilitaries for more than 20 years (Horgan, 2005, p. 100). In several cases, skilled craftsmen, who were otherwise employed by legitimate companies, carried out work on craft-produced firearms in the evenings (Forgotten Weapons, 2017).

In 1997, engineer Denis Lindop was convicted of manufacturing sub-machine guns for loyalist paramilitaries from his home workshop in Holywood, County Down (McCaffrey, 2005). Marked 'UFF Avenger 1995', the weapons were designed to accept custom-made suppressors and had serial numbers—a relatively uncommon trait for homemade weapons (Cadwallader, 2000). Some observers have interpreted these markings as

indicating that more than 300 examples were made; it is much more likely, however, that either the numbers were artificially high to confuse investigators, or that they indicated different production series (such as '200 series' and '300 series') or 'rack numbers' allocating the firearms to different operational units (Forgotten Weapons, 2017; Spencer, 1999).

The 'UFF Avenger' is a relatively sophisticated design, featuring a semi-telescoped bolt—a feature rarely seen on craft-produced weapons. It also has a folding butt-stock, the butt of which doubles as a forward grip in the closed position and is fed from Sten magazines (Forgotten Weapons, 2017; see Image 35). The suppressors for these weapons are sealed units that screw on to the barrel. The suppressors were ordered from a pressure vessel manufacturer as some sort of 'industrial muffler'; once identified, these orders led to the capture of the gun producer (Forgotten Weapons, 2017; Shea, 2007).

Image 35 A 'UFF Avenger' sub-machine gun, with serial number 303, seized from a loyalist paramilitary in Northern Ireland

© Jonathan Ferguson/ARES, courtesy of the National Firearms Centre/Royal Armouries

Latin America

An assessment of craft-produced sub-machine guns recovered by law enforcement and military forces in Latin America between 2012 and 2017, compiled in the ARES CONMAT Database, indicates that large numbers of these weapons are regularly seized from criminal groups. Although the firearms vary widely in quality and sophistication, a significant number have been regionally standardized and semi-professionally produced (ARES, 2018).

Their proliferation is particularly widespread in Brazil. A study of weapons seized in São Paulo in 2011–12 finds that 48 per cent of the recovered sub-machine guns were homemade (Instituto Sou da Paz, 2014b, p. 27). Two models in particular have been widely observed across Brazil, both chambered for 9 × 19 mm and displaying a high degree of workmanship compared to other examples. These models have been seized across multiple states, including Bahia, Rio de Janeiro, and São Paulo, suggesting an extensive distribution operation. The first model appears visually similar to the Brazilian-made URU sub-machine gun and usually displays the spurious marking 'Beretta, made in Italy' (see Image 36). The second model features a magazine well that serves as a grip.[76] This model is commonly marked 'AMT 8MM K MIAMI USA MAC-11' (ARES, 2018).[77] Both appear very similar in construction and finish, which could point to a shared origin.

Authorities have also seized uniformly craft-produced sub-machines guns in Colombia, Ecuador, and elsewhere. High-quality copies of industrially-produced firearms such as the Ingram MAC-10 and Intratec TEC-9 have also been seized, as have numerous crudely constructed examples of varying design (ARES, 2018; ImproGuns, 2014e). Efforts to counter the production and, in particular, the distribution of these illicit firearms in Brazil and elsewhere in Latin America would be greatly enhanced through more nuanced analysis of recovered examples.

Image 36 Examples of a widely seized model of craft-produced sub-machine gun with spurious Beretta markings, on display in Brazil

© Polícia Militar do Brasil

Australia

Police statistics show that approximately 10 per cent of firearms seized in the Australian state of New South Wales in 2014 were homemade (Morri, 2014). Since 2012, Australia has seen several widely publicized arrests related to production and distribution of homemade sub-machine guns, which included the conviction of Leon James Baird, an illicit gunsmith from Adelaide, South Australia. Baird supplied what police firearms experts dubbed 'the best homemade manufactured weapons in the state' (Rice, 2014). In 2014, a prospect[78] who aimed to join the Hells Angels Motorcycle Club's Sydney chapter was arrested with a craft-produced sub-machine gun that police contend was a prototype he planned on producing for the club (Morri, 2014). Homemade sub-machine guns seized in Australia are often based on designs found in books and instruction manuals that are widely available on the Internet (see Box 1). One such example was handed in during a national firearms amnesty in 2017 (NFWP-WG, 2017; see Image 37). Police have test-fired some of the devices for TV cameras—a testament to the generally rugged and safe construction of many of these weapons.

Canada

Canadian authorities have also seized significant numbers of craft-produced sub-machine guns from criminals. In December 2015, Toronto police found what was described as a 'Tec9' sub-machine gun in an abandoned vehicle (CityNews, 2015). The gun, actually a craft-produced copy of the Intratec TEC-9, was one of many produced at a plant in Montreal, Quebec. The Royal Canadian Mounted Police have since traced more than two dozen of these to 18 locations across Canada (Berthiaume, 2018).

The sub-machine guns in question were produced at a metal-working factory and feature two CNC-machined polymer halves used to form the frame of the gun, a distinguishing

Image 37 A Luty-type craft-produced sub-machine gun handed in during a national firearms amnesty in Australia, which ran from July to September 2017

© Australian Department of Home Affairs

Image 38 Components for a TEC-9-type craft-produced sub-machine gun recovered during a police raid on a factory in Montreal, Canada

© Royal Canadian Mounted Police

feature of other TEC-9/DC-10 copies (see Image 38). The barrels were threaded to accept craft-produced suppressors, also made in the factory. Two factory directors were charged with firearms offences; they had reportedly told factory employees that they were manufacturing parts for paintball guns (Berthiaume, 2018).

Chechnya

After the outbreak of the Second Chechen War in 1999, separatist insurgents began to craft-produce weapons. Locally-manufactured sub-machine guns became known by the name Borz (Chechen for 'wolf'). Early versions were close copies of the Armenian K6-92 under the name 'Eagle' (see Image 39); they were initially produced at the Krasny

Image 39 An early Chechen craft-produced copy of the K6-92 marked 'Eagle'

© Guns.ru

Molot factory in 1992, by the order of the first Chechen president (Dudayev, 2004; Popenker, n.d.). The name 'Borz' is also used as a generic term for craft-produced sub-machine guns with tubular receivers and often poorly finished parts, such as the ones produced in small workshops by separatist groups (Popenker, n.d.). Insurgents have used these weapons in attacks on security personnel and have often disposed of them at the scene after use. In 2014, a Borz cost as little as USD 100 (Dudayev, 2004).

Israel and Palestine

The Israel Defense Forces and local police have seized a significant number of craft-produced sub-machine guns in recent years, often in relation to conventional criminal activity, although certain arrests have been terror-related. The latter include an attack on border police on 3 February 2016, which resulted in the death of a policewoman, and an indiscriminate attack on a retail complex on 8 June 2016 (Beaumont, 2016; Cohen, Hasson, and Ravid, 2016). These sub-machine guns are often referred to as 'Carlo pistols', after the Swedish Carl Gustaf m/45 sub-machine gun and its Egyptian-made copies (known as the Port Said and Akaba), all of which have been used in the region. Visually-similar examples have been widely seized and are easily identified by the

Image 40 A 'Carlo' sub-machine gun among weapons seized en route from the West Bank into Israel in January 2016

© JDN

ringed or stepped profile of the barrel and use of an AR-15-type pistol grip, among other features (see Image 40). Recent analysis indicates that many of these visually-similar examples are produced by one or more illicit manufacturing operations with access to a capable distribution network (ARES, 2018; ImproGuns and Jenzen-Jones, 2016).

These sub-machine guns are most commonly chambered for the ubiquitous 9 × 19 mm cartridge; however, some are chambered for .22 LR, .32 ACP, 9 × 18 mm, or 5.56 × 45 mm. A slimmer 9 × 19 mm Uzi or homemade magazine is often concealed within the body of an AR-15-type magazine with a small screw for retention. The aim may be to fool security services at a distance, or to increase the propaganda or commercial value of the weapon (Gross, 2016). Carlo pistols have been employed by so-called 'lone wolf' terrorists, criminals, and militant groups such as Hamas's Izz ad-Din al-Qassam Brigades and Palestinian Islamic Jihad's Al-Quds Brigades (ARES, 2018).

According to Israeli authorities, these types of sub-machine guns began to appear around the year 2000 and have become more prolific in recent years, probably due to the high prices commanded by conventional automatic weapons. Analysis reveals that an AK-type self-loading rifle can cost as much USD 4,000–8,000 in the region, while a homemade sub-machine gun may cost around USD 500 (ARES, 2018). Other sources cite higher prices, from ILS 3,000 to ILS 10,000 (USD 750–2,500) for a basic 'Carlo' and from ILS 10,000 to ILS 15,000 (USD 2,500–3,800) for a model with a rifled barrel (Gross, 2016).

Rifles and light cannon

Rifles

Long arms with rifled barrels are considerably less common than other types of improvised and craft-produced weapons. Rifled barrels are difficult to produce and require a high level of skill and experience. If a rifled barrel is skilfully incorporated into the design of a weapon, it can markedly improve accuracy.

Wherever possible, manufacturers choose to obtain rifled barrel blanks or to repurpose rifled barrels from conventionally-produced arms. The costs of producing a rifled barrel—or acquiring a rifled barrel blank—tend to be significantly higher than those associated with other types of craft production. The market for rifles is also likely to be smaller in many regions, as rifles are inherently less concealable than other weapons, and most criminals have little occasion to use them. Users who do employ craft-produced rifles are likely to take specific precautions to prevent their seizure by law enforcement, meaning that few examples are documented. The level of manufacturing difficulty and the limited demand drive up prices, such that very few groups or individuals purchase these weapons.

Image 41 A gunsmith in Darra Adam Khel, Pakistan, whose gun-making industry is well-known for producing copies and derivatives of modern firearms

© Idealink Photography/Alamy Stock Photo

Danao in the Philippines and Darra Adam Khel in Pakistan's FATA region produce a high volume of relatively high-quality craft-produced rifles (ARES, 2018; see Image 41). Unlike conventional firearms, craft-produced weapons often reflect the aesthetics and influences of the local 'gun culture'. The rifle shown in Image 42, for example, has been crafted to look like an AK-type self-loading rifle. It is, in fact, a bolt-action rifle chambered for the 7 × 57 mm Mauser cartridge, most likely produced in the tribal areas of Pakistan or Afghanistan. The action body is based on the British Enfield Pattern 13/14 family of rifles, but the gun features entirely-decorative—and mechanically-pointless—features, such as a gas block, a fake 'cleaning rod', and AK-inspired wooden furniture. At least a handful of rifles of similar design have been documented (Ferguson, 2017).

Image 42 A craft-produced bolt-action rifle styled to look like a commercial AK-type self-loading rifle, most likely produced in Pakistan or Afghanistan

© N.R. Jenzen-Jones/ARES

Image 43 A copy of the Soviet SKS self-loading rifle believed to have been produced by the Viet Cong during the Vietnam War

Note: The close-up image shows the poor fit, crude finish, and obvious tool marks.

© Ian McCollum/ARES

The majority of craft-produced 'rifles' recovered in the field are, in fact, smoothbore guns. Even deactivated rifles that have been converted for lethal-purpose use commonly feature barrels that are not rifled (King, 2015). True craft-produced rifle barrels are rarely documented outside of established hubs such as Darra and Danao, and even weapons built around repurposed barrels or barrel blanks are very uncommon—although their use is increasingly common in larger-calibre craft-produced rifles, as discussed below. The Viet Cong produced some examples during the Vietnam War, although these were often quite crude (see Image 43). Nonetheless, some illicit producers have acquired specialized equipment for rifling barrels.

Anti-materiel rifles and light cannon

Non-state armed groups worldwide also craft-produce anti-materiel rifles (AMRs) and light cannon.[79] Although these weapons vary widely in quality and sophistication, one commonality is that the designs typically incorporate an industrially-produced barrel. Manufacturers generally remove such barrels from heavy machine guns, extract them from spare parts kits, or salvage them from damaged guns. In some cases, they employ barrels from light cannon. The most common calibres for craft-produced AMRs are 12.7 × 99 mm (.50 BMG), 12.7 × 108 mm, and 14.5 × 114 mm. Craft-produced light cannon are comparatively rare, and most commonly chambered for the Soviet 23 × 152B mm cartridge (see Image 44). The receivers of both of these types of weapons are usually fabricated from steel tubing and most often use a simple striker-fired mechanism and locked breech. Common features are large improvised muzzle brakes; mounting points for tripods, bipods, or vehicle pintle mounts; and padded stocks (ARES, 2018).

As discussed below, Syrian opposition forces have fabricated high-quality AMRs. More expedient construction methods for craft-produced AMRs are commonplace, however. They include the use of interrupted threads cut into the bolt to form barrel locking lugs. Construction methods such as this negate the need for the significant milling associated with constructing complex components and reduce the manufacturing requirements to only a handful of easily produced parts. An assessment of craft-produced AMRs

Image 44 This still from an Islamic State propaganda video shows fighters using a craft-produced light cannon chambered for 23 × 152B mm against Shia militia targets[80]

included in the ARES CONMAT Database showed that most AMRs produced in the Middle Eastern region follow this construction technique (ARES, 2018).

In addition to the forces discussed below, non-state armed groups and criminal organizations in Brazil, Chechnya, and Northern Ireland have also manufactured and employed AMRs (ARES, 2018). In the Philippines, the Moro Islamic Liberation Front produced AMRs chambered for 12.7 × 99 mm that were locally referred to as a *burit* or *barit*—a reference to the US Barrett M82, an iconic industrially-produced AMR. Eighteen relatively well-made examples were shown in a video taken at a clandestine weapons factory located in the autonomous region of Maguindanao in 2015 (ABS-CBN News, 2015).

Syrian opposition forces. Opposition forces in Syria have manufactured an advanced, magazine-fed bolt-action AMR referred to in propaganda videos as the Nimr 2. This rifle, chambered for the 12.7 × 108 mm cartridge, was produced in the workshops of Katibat Abu Asad al-Nimr, a group associated with the Hazzm Movement. The barrel used was originally made for the Chinese W-85 heavy machine gun, available from the Chinese state company Norinco and documented on numerous occasions in Syria. Other than the barrel, the Nimr 2 is entirely hand-fabricated and appears to have been produced with a relatively high level of skill. The tubular receiver is of steel; available video shows it being milled in a mill/drill machine, before undergoing extensive hand finishing in a bench vice. The bolt and long, tubular firing pin are also milled components, finished using an angle-grinder. A simple trigger mechanism is housed in a rectangular fitting with a rotating trigger-bar safety, which, along with a magazine well, is welded to the underside of the receiver. A length of standard MIL-STD-1913 accessory rail ('Picatinny rail') is attached to the top of the receiver (ARES, 2018; Ferguson, 2014a).

Syrian manufacturers fabricated the Nimr 2 magazines from sheet steel, rather than using a commercially-available example. One of the videos outlining the AMR's production shows a magazine being inserted into the magazine well to establish the proper seating depth and angle of presentation for the cartridge, a sign of a thoughtful production process. Even the single-chamber muzzle-brake is assembled from welded sheet steel. The rifles feature differing hand-produced furniture; one variant sports a custom wrap-around wooden stock and a fixed tubular bipod, while the other has an off-the-shelf plastic AK-type pistol grip and homemade skeletal butt-stock and folding bipod. The absence of the factory-standard muzzle brake may imply that these barrels were originally spare parts, rather than recovered from damaged weapons. In available videos, the complete weapon is test-fired several times, apparently with success, although its accuracy cannot be assessed (Ferguson, 2014a).

Kurdish forces in Iraq and Syria. The Kurdish People's Protection Units (YPG) manufacture and employ several varieties of craft-produced AMRs. They make use of three primary models, along with several experimental varieties.[81] The primary rifles in service are the Zagros, chambered for 12.7 × 108 mm, and the Şer and Şer Portative, chambered for 14.5 × 114 mm (see Image 45). The YPG also built conceptually similar guns

Image 45 A 14.5 mm Ser Portative (foreground) and a 12.7 mm Zagros (background)

Note: Picture taken during the 7 July 2016 Battle for Manbij in Syria.

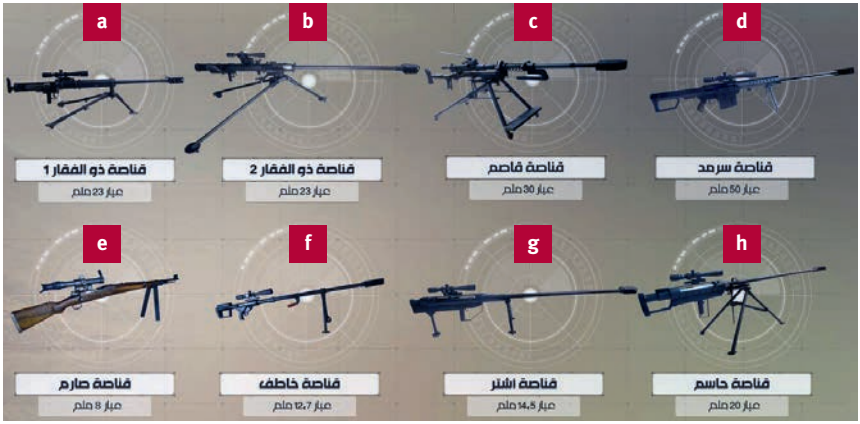
© ARES

(which are technically light cannon) around the 23 × 152B mm cartridge but subsequently determined that they were too heavy and bulky to be employed effectively in most scenarios. In craft-producing AMRs, YPG gunsmiths fabricate simple tubular receivers and bolts to match spare or recovered barrels taken primarily from DShKM-, W-85-, and KPV-pattern guns (McCollum, 2017).[82]

These rifles have proven their value in the defence against vehicle-borne IEDs, while serving a secondary role as counter-sniper weapons. YPG forces have employed them to make up for shortages of conventional AMRs, such as the Chinese M99, Zastava M93, and Barrett M82 (McCollum, 2017). As in most conflict zones, these AMRs are primarily used with machine gun ammunition, rather than precision ammunition that is more suitable to sniper-type engagements. Nonetheless, available ammunition—such as armour-piercing and armour-piercing incendiary—has been used to advantage against armoured vehicles and materiel.

Houthi forces in Yemen. In Yemen, the Houthi have employed a particularly broad range of cartridges among their craft-produced AMRs and light cannon; these range from 12.7 mm through to 30 mm in calibre (ARES, 2018). In addition to the relatively conventional Khatef and Ashtar in 12.7 × 108 mm and 14.5 × 114 mm, respectively, Houthi forces have produced the Hasem in 20 × 102 mm, the Zulfiqari 1 and Zulfiqari 2 in 23 × 152B mm, and the Qassem in an unspecified 30 mm cartridge (Lyamin and ImproGuns, 2017; see

Image 46 Six craft-produced AMRs manufactured by Houthi forces in Yemen, plus two industrially-produced rifles (a Mauser type, at bottom left, and a Barrett M82 type, at top right)



Notes:

All craft-produced designs make use of repurposed barrels taken from heavy machine guns and light cannon in a range of calibres, from 12.7 to 30 mm.

a) Zulfiqari 1, a 23 × 152B mm craft-produced bolt-action rifle weighing less than 25 kg with a claimed effective range of up to 2,000 m.

b) Zulfiqari 2, a larger version of the Zulfiqari 1 weighing some 62 kg, with a claimed maximum effective range of 4,000 m.

c) Qassem, a 30 mm craft-produced light cannon, with a weight of 75 kg and a claimed maximum effective range of 5,000 m.

d) Sarmad, an industrially-produced Barrett M82A1-type self-loading rifle chambered for 12.7 × 99 mm (.50 BMG).

e) Sarem, an industrially-produced Mauser Kar 98k-type bolt-action rifle chambered for the 7.92 × 57 mm cartridge.

f) Khatef, a 12.7 x 108 mm craft-produced bolt-action rifle, with a weight of 14 kg and a claimed maximum effective range of up to 1,500 m.

g) Ashtar, a 14.5 × 114 mm craft-produced bolt-action rifle, with a weight of 28 kg and a claimed maximum effective range of 3,000 m.

h) Hasem, a 20 × 102 mm craft-produced bolt-action rifle, with a stated weight of 28 kg and a claimed maximum effective range of 2,500 m.

Source: Lyamin and ImproGuns (2017)

Image 46). While the production standards remain basic, Houthi weapons appear relatively well made compared to designs documented elsewhere.

Like non-state armed groups in other conflict areas, the Houthi repurpose barrels from industrially-manufactured guns. The 20 mm barrels of the Hasem, for example, are taken from US 20 mm M167 Vulcan Air Defense Systems and their copies, which are typically

mounted on vehicles. Some of the Houthi weapons incorporate novel design elements, such as the external spring assemblies fitted to the two known minor variants of the Qassem, which are presumably designed to mitigate substantial recoil forces. One of these variants makes use of a pair of motorcycle shock absorbers (Lyamin and ImproGuns, 2017).

“Craft-produced smooth-bore guns that fire explosive or incendiary projectiles . . . are or were in service with many non-state armed groups, from the Middle East and North Africa to Latin America, Chechnya, Northern Ireland, and elsewhere.”

VII. Improvised and craft-produced light weapons

Grenade launchers and rifle grenades

Craft-produced smoothbore guns that fire explosive or incendiary projectiles—known as 'grenade launchers'—are or were in service with many non-state armed groups, from the Middle East and North Africa to Latin America, Chechnya, Northern Ireland, and elsewhere (ARES, 2018). Many of these groups were or remain involved in fierce urban fighting and thus expend significant quantities of ammunition for indirect fire systems—both conventional and improvised—including grenade launchers, mortars, and rocket launchers. In many cases, armed groups supplement conventionally-produced munitions with improvised rounds, which are employed in anti-armour, anti-structure, and anti-personnel roles. The need to 'shoot and scoot' from range, so as to limit threats to the user, seems to be another driver in the popularity of these types of weapons among non-state armed groups. Variants within weapon types remain broadly similar across different groups. The availability of materials and varying levels of expertise shape the type and level of sophistication of improvised rifle grenades and their launchers.

Improvised rifle-launched grenades

For several decades, insurgents around the world have been adapting improvised explosive or incendiary projectiles to be fired from shotguns or rifles. These were largely born from the exigencies of trench warfare during the First World War, which gave rise to 'cup-type' launchers intended for use with an explosive projectile and blank cartridges, although similar cup-launcher muzzle devices were used on flintlock arms hundreds of years ago (Ferguson, 2013; Saunders, 2012; Walton, 1894, p. 745). In the 1960s, militaries supplanted cup-type launchers with grenades designed to fit over the muzzle of a firearm (rifle grenades); more recently, they have used under-barrel and stand-alone launchers. Nevertheless, cup-type launchers continue to represent a viable launching method for those with limited means.[83]

In *Guerrilla Warfare*, Che Guevara describes—and provides a diagram of—a crude cup launcher device designed to launch a Molotov cocktail (Guevara, 1961).[84] In the early 1970s, the Provisional IRA experimented with a shotgun-fired improvised grenade attached to a wooden dowel and fitted with a length of safety fuse,[85] based on a design presented in a US Army manual (Jenzen-Jones, 2017a). Due to unreliability and safety concerns, the grenade saw limited use and was quickly dropped in favour of improvised mortar systems (Geraghty, 2000).

In recent years, cup-type launchers have made a comeback among non-state armed groups in Iraq, Libya, Syria, and elsewhere (ARES, 2018). The construction of such launchers involves attaching a 'cup' to the end of the barrel of a long arm, usually a shotgun chambered for 16-gauge or 12-gauge cartridges, and loading a blank cartridge

Image 47 A Free Syrian Army fighter uses an improvised 'cup-type' rifle grenade launcher during a fight in Damascus, January 2013

© Goran Tomasevic/Reuters

(or an improvised blank, made by removing the projectile or shot from a 'live' cartridge) into its chamber. The next step is to insert an improvised grenade or incendiary—the fuse or ignition device is generally manually initiated before firing—into the cup (see Image 47). The expanding gasses generated by the blank cartridge then propel the grenade or incendiary from the cup.

Range and accuracy vary significantly based on the design, gas-seal between the projectile and cup, cartridge type, weapon, and other factors. The hazards of this arrangement range from premature ignition of the grenade itself to the inadvertent discharge of a live cartridge, which is likely to damage the weapon and harm the user. Sighting arrangements are typically absent, and aim point—as well as the length and burn time of the fuse—must all be judged by eye.

Craft-produced grenade launchers used by Chechen separatists

The Lom-30 ('Lion-30') is a shoulder-fired grenade launcher[86] manufactured by Chechen rebels for whom factory-produced ammunition is somewhat readily available. The Lom-30 is chambered for conventional 30 × 29 mm VOG-17-type projectiles, which are ordinarily used with the Soviet AGS-17 automatic grenade launcher. Separatist sources note that the Lom-30 weighs 6.5 kg and claim a very optimistic effective range of up to 2 km.[87]

Image 48 A 'pistol-sized' grenade launcher manufactured by Chechen separatists, capable of firing conventional VOG-25 grenades

© Liriko77

Separatists also produce a more crudely assembled grenade launcher that is chambered for the 40 mm VOG-25-type caseless projectiles usually fired from the GP-25 and GP-30 series of under-barrel grenade launchers (see Image 48). This grenade launcher is the size of a large pistol or small sub-machine gun and can be concealed under a jacket, making it ideal for close-up attacks on security personnel at checkpoints and for easy disposal (ARES, 2018; NEWSru, 2004).

Improvised grenade launchers used by Syrian rebel forces

Groups affiliated with the Free Syrian Army have released videos that show the construction and the use of crude shoulder-fired grenade launchers of a standardized design (see Image 49). The weapon appears to fire a fin-stabilized projectile[88] that is propelled by a blank shotgun cartridge and is similar in appearance to a mortar projectile. The launcher features a cocking lever that protrudes from the rear. The lever is released via a side-mounted trigger assembly, driving a firing pin against the cartridge primer. Firers can expect to experience significant recoil, which is why some versions feature a large shoulder pad. The number of videos in existence about these weapons is limited, suggesting that they may not have seen extensive use in combat (ARES, 2018).

Image 49 Screenshots from a video demonstrating loading and firing of an improvised grenade launcher in Syria[89]

Craft-produced rifle grenades used by Islamic State forces

Islamic State forces have made widespread use of an indigenously developed and produced type of rifle grenade (see Image 50). This weapon features a milled[90] white plastic (probably nylon) body paired with an impact fuze of Islamic State design, typically used with craft-produced mortar projectiles. The group originally developed and employed these munitions as rifle grenades that could be fired from cup-type muzzle attachments. Since then, however, the fighters have increasingly thrown them by hand or used them as air-delivered weapons by deploying them from small, commercial off-the-shelf UAVs (ARES, 2018; see Box 5).[91]

In the latter half of 2016, the first sightings of weaponized Islamic State UAVs were reported. The rate at which Islamic State forces have attacked with armed UAVs, including those carrying craft-produced air-delivered weapons, is noteworthy. Only a handful

Image 50 An Islamic State craft-produced multi-purpose air-delivered weapon and rifle grenade made from a custom body/tail unit and Islamic State standardized impact (mortar) fuze

Source: Fulmer and Jenzen-Jones (2017)

of attacks were reported prior to December 2016. A few dozen took place in January 2017. In February 2017 alone, however, Islamic State forces conducted more than 200 attacks with UAVs armed with light weapons[92] (ARES, 2018; Fulmer and Jenzen-Jones, 2017; Wright and Jenzen-Jones, 2018).

Improvised grenade launchers used by Republican dissidents in Northern Ireland

Prior to the introduction of the PRIG, which is discussed below, the Provisional IRA developed and employed an improvised grenade launcher known as the Improvised Projected Grenade, or IPG (see Image 51). This design generated significant recoil; security forces supposedly treated shoulder bruises as evidence in investigations designed to identify IPG shooters (Geraghty, 2000). In August 1985, an operator was killed through careless handling while attempting to fire the weapon at a police Land Rover in Londonderry. IPG launchers quickly fell out of favour with volunteers following the incident (Smith, 2006).

In November 2014, Republican dissidents employed an improvised grenade launcher of a different design in targeting a Police Service of Northern Ireland patrol vehicle in northern Belfast. The weapon was of relatively crude construction: its trigger mechanism apparently consisted of a repurposed Makita electric impact drive, secured inside a steel tube with electrical tape. The militants reportedly fired the launcher from a range of around 20 metres and struck the target, thus functioning the improvised munition (ImproGuns, 2014c; McMahon, 2014). The projectile was allegedly craft-produced and fitted with a high explosive (Semtex) payload. During the attack, it did not pierce the primary ballistic armour of the vehicle. In contrast, a PRIG attack in 1994 on an armoured Royal Ulster Constabulary (RUC) Land Rover resulted in significant damage and the

Image 51 An IPG launcher (foreground) as used by the Provisional IRA in Northern Ireland

© PIRA

death of an RUC officer. The emergence of the more recent design, which is notably less sophisticated than earlier Provisional IRA models, suggests that today's militants have no ties to veterans of their 'Engineering Department' (ImproGuns, 2014c).

Improvised grenade launchers in Latin America

A variety of crude improvised grenade launchers are used across Latin America. They appear to be most commonly employed in conjunction with anti-government protests in some states. In Venezuela, weapons of this type became more widespread during protests in 2014 and 2017. In Nicaragua, they have been relatively common since the late 1990s, with widespread use during protests commencing in April 2018 (ARES, 2018; Solano Martínez, 2010).

Image 52 Young men with mortar launchers during protests against the government of Daniel Ortega, Managua, Nicaragua, July 2018

© Jorge Torres/EFE/Alamy Live News

Image 53 A man with a shoulder-fired improvised grenade launcher during clashes with government forces during protests in Venezuela, 2017. A lit fuse protrudes from the muzzle

© Jamez42/Wikimedia Commons

While these weapons are known in several Latin American countries as *morteros caseros* ('homemade mortars'), they are better described as grenade launchers. They can be short in overall length, with only a single crude pistol grip; some can be fired single-handedly. Many feature a long barrel or a forward grip, allowing for a more secure two-handed firing position (see Images 52 and 53). Others are fitted with a basic shoulder stock in addition to, or instead of, the forward grip, or they may be of sufficient length to be fired in an over-the-shoulder manner.

These weapons generally operate on the same simple principle: a propellant charge is loaded into a crude barrel arrangement sealed on one end and is then ignited to propel an explosive projectile, often clad with makeshift fragmentation material such as nails, ball bearings, marbles, and rocks.[93] In many cases, readily-available and often legal fireworks are used. In other cases, makeshift munitions are first assembled from a firework or loose propellant, projectiles, and a fuse of some type, and then typically bound together with paper and tape.[94] In both cases, the user lights a long fuse that protrudes from the muzzle to fire the munitions. A limited number of larger examples operate on the same principle; they would be more accurately described as mortars, particularly those fitted with baseplates and bipods (ARES, 2018).

Recoilless guns

RPG-2 type recoilless guns[95]

Since 2004, the Izz ad-Din al-Qassam Brigades of Hamas have produced a relatively high-quality copy of the Soviet RPG-2 shoulder-fired recoilless weapon known as the Yasin, named after Sheik Ahmed Yasin, who was assassinated by Israeli Defence Forces in 2004 (BBC, 2004). The group also produces projectiles for the weapon, one of which incorporates a shaped charge warhead with stand-off probe to increase effectiveness against armour (MEMRI, 2010). A propaganda video released by the group shows the weapon being assembled by hand in a typical small workshop filled with prefabricated components. The video also shows explosive filler—probably molten TNT mixed with powdered ammonium nitrate (a combination known as Amatol)—being prepared and then poured from a tap into each warhead (ARES, 2018; Jenzen-Jones, 2017a).

Image 54 Muslim rebels in the Philippines stand at attention with their weapons, October 2012

Note: In the foreground, a craft-produced copy of the RPG-2 is partially visible.

© Ted Aljibe/AFP Photo

The rebel fighters of the Moro Islamic Liberation Front in the Philippines also manufactured copies of the RPG-2 launcher and PG-2 projectiles (see Image 54).[96] A Filipino senator has accused the group of manufacturing various weapons at a facility in southern Mindanao (ABS-CBN News, 2015). RPG-2-type weapons are also produced by the Ta'ang National Liberation Army in Myanmar; they are generally popular with non-state armed groups due to their simplicity of manufacture (ARES, 2018).

Much like German Panzerfaust weapons of the Second World War, the RPG-2 is a simple, straight tube, which limits its effective range and payload weight; at the same time, it is much simpler to produce than more complex systems that incorporate divergent conical arrangements, such as the RPG-7 (Newhouse, 2011). Incorrect manufacture of the propelling charge for the RPG-2 can lead to significant reductions in the range of the weapon and, occasionally, to catastrophic failures.

Other recoilless weapons

In the early 1990s, the Provisional IRA developed a weapon that British security forces dubbed the Projected Recoilless Improvised Grenade, or PRIG. It was designed to serve as a disposable shoulder-fired launcher that could fire an armour-piercing projectile. The launcher made use of a physical countermass to mitigate recoil and allow for use in relatively confined spaces (Geraghty, 2000).

The PRIG design featured a launch tube made from a length of steel pipe with a perforated propellant chamber that was centrally located and made from a pipe nipple and cap. Its projectile consisted of a metal can filled with some 500–700 g of high-explosive composition (see Image 55).[97] The front of the tin incorporated a hollow metal cone to create a simple shaped charge.[98] A long lever arm micro-switch wired to a simple circuit acted as a trigger that initiated the propellant charge in the chamber via a flash bulb. Whereas contemporary recoilless weapons used propellant gasses, water, or small plastic flakes as a solid countermass, the PRIG made use of two packets of 'digestive' biscuits wrapped in household cleaning cloth, which would be ejected rearward upon firing, significantly reducing the weapon's felt recoil (ImproGuns, 2014b; IWM, n.d.).[99]

The simplicity of the design eliminated many of the construction tolerance and recoil problems associated with earlier improvised launchers. Both the projectile and launcher were extremely quick and easy to manufacture and the associated design knowledge and manufacturing skills could be easily disseminated as needed. The PRIG was used in at least 11 attacks during the early 1990s and featured heavily in Provisional IRA training footage released for information warfare purposes (ImproGuns, 2014b).

Improvised recoilless weapons of a similar design were observed in the hands of FARC militants in Colombia (ARES, 2018). The FARC received extensive assistance in munitions design from members of the former Provisional IRA's engineering team (Chalk et al.,

Image 55 A Provisional IRA shoulder-fired projected recoilless improvised grenade launcher (left) and its projectile (right)

© Imperial War Museum London

2007; see Box 4). In a video showing training with a PRIG-type weapon, dubbed the '80 mm *cañón*', a FARC member loads a craft-produced projectile into the launcher, followed by a charge of propellant attached to a countermass contained in a section of PVC pipe (see Image 56). The command wire to the charge appears to run through the middle of the counter-shot and out the rear of the launcher (ARES, 2018). The FARC design made use of a pre-assembled powder charge and counter-shot assembly to improve reloading time and reduce the user's risk of inadvertently omitting an element during the loading process (ARES, 2016).

Image 56 Screen shots showing the loading of a recoilless launcher tested by FARC guerrillas

© Noticias Caracol

In May 2017, Islamic State forces released a propaganda video purporting to show production capabilities of light weapons in the Iraqi city of Mosul. The video showcases a lightweight, uniformly produced anti-tank weapon visually similar to the German Armbrust recoilless launcher. Subsequent propaganda releases show at least four variants that make use of conventionally-produced PG-7V- and PG-9-type munitions, as well as what are presented as 'thermobaric' munitions (ARES, 2018; Southfront, 2017).

Mortars

Relatively lightweight improvised mortars[100] have long featured as part of the guerrilla's arsenal. Numerous non-state armed groups have developed and produced improvised and craft-produced mortars, including the FARC in Colombia, Euskadi Ta Askatasuna (ETA) in Spain, the Liberation Tigers of Tamil Eelam (LTTE) in Sri Lanka, Palestinian

Image 57 A craft-produced mortar launcher seized by Israeli Defence Forces in Gaza's Tel al-Hawa neighbourhood in 2002

© Israel Defense Forces

militant groups in Gaza, and various forces operating in Iraq and Syria, including Jaish al-Islam, the Islamic State, and several groups associated with the Free Syrian Army (ARES, 2018; Davies, 2001; IDF, 2002; see Image 57). As discussed above, the FARC received considerable training in the construction and use of these systems from Provisional IRA engineers (Chalk et al., 2007; see Box 4).

A typical improvised mortar consists of a cylindrical firing tube, either welded closed at the base end or adapted from a commercial gas cylinder (pressure vessel) with the top removed. Mortar projectiles may be fabricated from cylindrical pipe fittings or, in the case of larger examples, they may be adapted from commercial gas cylinders, sometimes with stabilizing fins added.

Among the most common explosive compositions used in large projectiles are blends of ammonium nitrate and fuel oil (AN/FO), which are cheap and easy to produce in bulk

Image 58 An improvised, electrically-initiated, remote-fired mortar design employed by Islamic State forces in Mosul, in October 2016

© Aris Roussinos

quantities. Smaller bombs may be filled with more powerful and sensitive compositions, such as blends of ammonium nitrate and aluminium (AN/Al) or TNT with a phlegmatizer.[101] Use of explosive compounds reclaimed from conventional ordnance that has failed to function or degraded in storage is a common practice in Syria and Iraq (ARES, 2018; Jenzen-Jones, 2017a).

In smaller mortars, a projectile incorporating a propellant charge[102] may be dropped into the launch tube to be struck by a fixed firing pin attached to the base of the device. In larger models, an electrically-initiated firing system is often used to ignite a separate propellant charge.[103] Many designs are intended to be fired remotely, such as those used by the Front for the Liberation of Occupied South Yemen during the Aden Emergency, the Provisional IRA, the FARC, and, more recently, the Islamic State (ARES, 2018; see Image 58).

Larger improvised and craft-produced munitions, including mortar projectiles, may be developed to deliver purpose-designed chemical weapons or toxic industrial chemical payloads. Islamic State forces have employed both types of chemical agents. The Organisation for the Prohibition of Chemical Weapons reported that in 2015 and 2016, Islamic State forces fired mortar projectiles filled with sulfur mustard, a blister agent regulated under the 1993 Chemical Weapons Convention (OPCW, 2016, para. 59, annex X; 2017, paras. 26, 36(f), annex I).

The Provisional IRA have perhaps best demonstrated the successful development, testing, and employment of these weapons, as the group developed at least 17 and perhaps as many as 21 different models over a span of 40 years (Oppenheimer, 2008). These weapons range from the man-portable models discussed in this section, to batteries of heavy units constructed from large commercial heating-gas cylinders that fire large munitions capable of causing significant damage to military and police installations. In 1994, a projectile from a Mark-15 'Barrack Buster' improvised mortar hit a British Army Lynx helicopter in flight, severing part of its tail boom and forcing the pilot to make an emergency landing (*Telegraph*, 1994). A battery of Mark-10 mortars (with projectiles crafted from oxy-acetylene cylinders) concealed in a van[104] was used in an attempted attack on 10 Downing Street in 1991, as well as in an earlier attack targeting an RUC facility in Corry Square, Newry, in 1985. In the latter incident, a single mortar round killed 9 RUC officers and injured 3 soldiers, 3 RUC officers, and 38 civilians (Oppenheimer, 2008; Whitney, 1991).

In October 1974, having wrestled with a series of earlier models that were plagued by inaccuracy and a tendency to fail catastrophically, the IRA used its first effective, man-portable mortar, which security forces labelled the Mark-6 (Smith, 2006, p. 146). The Mark-6 mortar projectile incorporated a wind-driven impeller that screwed down a striker during flight, arming the bomb for impact. Different versions allowed the projectile to be manually dropped into the launch tube; alternatively, it could be fired

electronically via a timing and power unit, a method that offered the operator increased safety (Oppenheimer, 2008).

An effective, man-portable direct-fire mortar came into the IRA's arsenal with the development of the Mark-12, which was first used in conjunction with the Mark-11 during an attack on a Security Force Base in Crossmaglen, in October 1989. Used in a two-stage attack, the two Mark-11 rounds were intended to compromise and force aside the outer steel mesh—which had been put in place to protect against attacks using the Mark-10—while the armour-piercing Mark-12 projectiles would impact directly against the wall (Ryder, 2005). The Mark-12 mortar round was welded together from sheet steel and contained an explosive charge comprised of approximately 5 lbs (2.3 kg) of Semtex. It incorporated a high-explosive anti-tank-shaped charge warhead design, which enabled it to engage armoured vehicles effectively, and arguably to function as a type of off-route mine (Oppenheimer, 2008).

In March 1993 the miniaturized Mark-16 superseded the Mark-12, largely because it required only half the quantity of explosive to achieve a similar effect on target (Smith, 2006). An individual could easily transport it in a duffle bag and place it on top of available terrain or built-up features so that it might be fired at a passing target vehicle via command wire.

Authorities in Colombia have regularly encountered mortars constructed much like the original Provisional IRA Mark-14—using projectiles fabricated from household gas cylinders. In Syria, opposition forces have made extensive use of various large-calibre improvised mortars that also fire gas cylinder projectiles (ARES, 2018).

Rocket launchers

Authorities have frequently seized improvised man-portable rocket launchers from insurgent caches in Iraq and Afghanistan; meanwhile, armed groups have also fielded the weapons in Chechnya, Libya, Syria, and Ukraine. Launchers of this type are generally designed to fire conventional, widely available air-to-surface rockets, especially the Soviet 57 mm S-5 series. Launchers chambered for other, larger types, such as the French 68 mm SNEB and Soviet 80 mm S-8 series, are also encountered, although their rocket motors generate significant backblast, which means that the launchers must typically be used from a fabricated mobile platform rather than fired from the shoulder (ARES, 2018; NGIC, 2004).[105]

Improvised man-portable rocket launchers are generally employed as direct-fire weapons against personnel, vehicles, and structures. In some cases, they are employed against low-flying (primarily rotary-wing) aircraft or used in an indirect-fire role. When used with repurposed munitions such as the S-5, these weapons offer greater stand-off capability than common shoulder-fired recoilless weapons such as the RPG-7, and

the greater velocities result in flatter trajectories and decreased times of flight. The accuracy of these weapon systems is generally poor, however, especially at longer ranges. When employed in an indirect-fire role, the chances of hitting a point target with a repurposed air-to-surface rocket are incredibly slim (Lyamin and Jenzen-Jones, 2014). Armed groups have acquired a variety of S-5 rocket types with different payloads, including high-explosive anti-tank (S-5K) and high-explosive fragmentation (S-5M) warheads (Markovsky and Perov, 1994). Craft-produced designs of the same approximate dimensions have also been documented, although these are rare. In many conflict zones, fragmentation munitions for common shoulder-fired light weapons, such as the RPG-7, are often scarce; their availability in the form of S-5 series rockets translates into a greater potential to inflict damage to enemy personnel (ARES, 2018).

Launchers may be single- or multi-barrelled and are typically constructed from steel or aluminium tube, with varying arrangements of pistol grips, handles, or wooden thumbhole stocks. The launchers are typically cheap and disposable, as they are constructed from locally-available materials (see Image 59). Once stockpiles of rockets come into a group's possession, constructing viable launch tubes requires only basic knowledge of how to wire a simple circuit to the rocket motor's initiator.[106] Electronic initiation is commonly provided via a 9-volt battery wired to a switch, which in turn leads to the rocket's initiator (NGIC, 2004). In particularly crude examples, a switch may be absent, and the battery may be carried separately and applied directly to the wiring at the time of firing. In some cases, iron sights or factory-made optical sights may be attached to allow for high-elevation adjustments (ARES, 2018). Proper zeroing of such sights may prove difficult or impossible, however.

Image 59 A Soviet S-5 rocket alongside an improvised shoulder launcher. A PGO-7V optical sight from an RPG-7 has been added

© National Ground Intelligence Center

Box 5 Improvised and craft-produced air-delivered weapons[107]

Both armed forces and non-state armed groups have developed and employed improvised and craft-produced air-delivered weapons. Such designs have primarily served to sustain needs for explosive munitions in intense battles, or to provide capabilities that are not otherwise available to belligerents.

Improvised air-delivered munitions in Iraq and Syria underwent rapid development from 2012 to 2017, ranging from the Syrian Armed Forces' development of the 'barrel bomb' deployed from manned aircraft (see Image 60), through to the design and rapid expansion of air-delivered improvised munitions and modified conventional ordnance deployed from small, commercial off-the-shelf UAVs, as demonstrated by the Islamic State and other non-state and state groups (ARES, 2018; Fulmer and Jenzen-Jones, 2017).[108]

Improvised air-delivered munitions have also been used to deliver chemical weapons. Syrian government forces have employed munitions to disperse industrial chlorine in a number of incidents,[109] several of which took place in densely populated areas. The munitions are of relatively crude design but have also been effective from a psychological warfare perspective, in addition to raising the ire of the international community (CoI Syria, 2017).

Image 60 An improvised unguided aerial bomb in Darat Izza, Syria, in August 2016[110]

Note: This weapon failed to function. Its exposed main charge consists of explosive material taken from a Soviet UR-77 MCLC system and supplemented with bulk loose explosives. A red detonating cord and reinforcing bar ('rebar') fragmentation are also visible.

Source: Fulmer and Jenzen-Jones (2017)

“The operation of improvised or craft-produced small arms and light weapons—as opposed to professionally-manufactured weapons—often poses significantly higher safety risks for users and bystanders.”

VIII. Safety and normative considerations

Safety considerations

The operation of improvised or craft-produced small arms and light weapons—as opposed to professionally-manufactured weapons—often poses significantly higher safety risks for users and bystanders. As discussed above, individual classes and types of weapons can suffer from shortcomings that range from the poor quality and consistency of raw materials (including improper material selection, heat treating, and finishing) to insufficient manufacturing tolerances and a lack of quality control or proof-testing, all of which result in dubious chamber, barrel, and action integrity. In turn, these weaknesses greatly increase the risk of catastrophic failure, in which case the weapon is rendered useless and the firer may be injured or killed. If ammunition has been hand-reloaded or wholly or partly improvised, further problems may arise from too much or too little propellant, under- or over-calibre projectiles, insensitive or over-sensitive primers, and other factors.

Quite apart from these endemic problems with improvised and craft-produced firearms, controlling for correct cartridge headspace is another serious issue for designs that require the use of high-pressure conventional ammunition. Even if a weapon is otherwise well made, insufficient headspace will prevent reliable feeding, and excessive headspace can result in catastrophic weapon failure and harm to the user (Ferguson, 2015).

In view of these factors, craft-produced and improvised firearms tend to be chambered for relatively low-pressure cartridges, such as .22 Long Rifle, .380 ACP, and shotgun cartridges. Similarly, improvised and craft-produced light weapons tend to fire low-velocity projectiles or rockets, which do not exert the same pressures on a weapon system as many conventional artillery or support-weapon projectiles. However, there are other, less dramatic dangers inherent in the use of improvised or craft-produced weapons under combat conditions. Weapons need not directly harm users to put their personal safety at risk. Given that poor-quality magazines, especially magazine springs, and crudely manufactured magazine wells and feed ramps are commonplace, employing certain models of improvised and craft-produced weapons increases the risk of stoppages or failures-to-feed significantly. Poorly manufactured critical components, such as firing pins—which may be either too brittle or too malleable—can cause a weapon to experience a failure-to-fire. While not as disastrous as a catastrophic failure, these problems can still expose the user to significant danger during armed conflict.

These shortcomings are also likely to reduce an individual user's or group's confidence in a weapon, which can limit its effectiveness even before any malfunction presents itself. This type of issue seriously affected the British Army in 1991, when UK troops deployed to the Gulf War in what was termed Operation Granby. Platoon commanders expected to sustain extra casualties during fortification-clearance operations, specifically because infantrymen lacked confidence in their stoppage-prone weapon systems (LANDSET, 1991, as cited in Raw, 2003). Given that low levels of confidence in

the reliability of weapons can have a serious impact on trained soldiers, the effects on untrained or poorly trained insurgents and armed criminals are also likely to be substantial, especially among those operating in urban areas or close terrain. Consequently, most unauthorized users prefer factory-built weapons to their improvised and craft-produced counterparts.

Regulatory requirements

Regardless of whether craft production is a response to insecurity, economics, or tradition, it can be difficult for governments to regulate or restrain (Batchelor, 2003). Broadly speaking, national and international controls apply to improvised and craft-produced small arms and light weapons in the same ways as they do to their traditionally-manufactured counterparts. However, many of the 'raw' component materials are unrestricted, or regulated as dual-use items. In addition, some exemptions apply to 'replicas of antique weapons', as discussed below. Moreover, craft-produced and improvised weapons present some specific challenges for enforcement operations.

Applicable norms

Improvised and craft-produced small arms appear to be largely excluded from the classification of 'small arms and light weapons' used in the United Nations *Report of the Panel of Governmental Experts on Small Arms*, which does not cover smoothbore guns or shotguns in its five, limited categories. Smoothbore craft-produced sub-machine guns may or may not be included, depending on the definition used. The report largely covers light weapons, however, along with the majority of ammunition used in craft-produced weapons (UNGA, 1997).[111]

The later Firearms Protocol and International Tracing Instrument (ITI) contain more comprehensive definitions of 'firearm' and 'small arms and light weapons', respectively (UNGA, 2001a; 2005).[112] The Firearms Protocol defines a firearm as:

> any portable barrelled weapon that expels, is designed to expel or may be readily converted to expel a shot, bullet or projectile by the action of an explosive, excluding antique firearms or their replicas [manufactured before 1899] (UNGA, 2001a, art. 3(a)).

This definition clearly covers most of the improvised and craft-produced firearms discussed in this report;[113] however, the case could be made that some of the weapons in question constitute replicas of antique firearms, and thus are not covered under the Firearms Protocol.

The ITI similarly defines small arms and light weapons as:

> any man-portable lethal weapon that expels or launches, is designed to expel or launch, or may be readily converted to expel or launch a shot, bullet or projectile by the action of an explosive, excluding antique small arms and light weapons or their replicas (UNGA, 2005, para. 4).

Although certain copies of antique designs may arguably be exempt from the ITI provisions, the definition covers the vast majority of improvised and craft-produced small arms and light weapons.[114] Smoothbore guns and shotguns, which are conspicuously absent from the ITI's list of examples (itself drawn from the 1997 UN expert panel report), are also covered by this definition.[115] A similar 'antique or replica' exemption may arguably be applicable to many, however.

Regulation of arms manufacturing

The Firearms Protocol addresses the regulation of improvised and craft-produced firearms. It defines illicit manufacturing as:

> the manufacturing or assembly of firearms, their parts and components, or ammunition:
>
> (i) From parts and components illicitly trafficked;
>
> (ii) Without a licence or authorisation from a competent authority of the State party where the manufacture or assembly takes place; or
>
> (iii) Without marking the firearms at the time of manufacture, in accordance with article 8 of [the Firearms Protocol] (UNGA, 2001a, art. 3(d)).

The Protocol also requires states to criminalize the intentional 'illicit manufacturing of firearms, their parts and components and ammunition' (UNGA, 2001a, art. 5.1(a)).

Similarly, provisions in the United Nations Programme of Action (PoA) address the illicit manufacture of small arms and light weapons.[116] These apply to improvised and craft-produced firearms in the same way they do to their conventionally-produced counterparts. Specifically, the PoA requires states to 'exercise effective control over the production of small arms and light weapons within their areas of jurisdiction' (UNGA, 2001b, para. II(2)). Under the PoA, states also commit to criminalizing the illicit manufacture of small arms and light weapons and to taking steps to identify and take action against groups and individuals engaged in the illicit manufacture of small arms and light weapons (paras. II(3), II(6)).

In practice, the regulation of craft manufacture can be more challenging than the control of conventionally-produced weapons. In some jurisdictions, authorities regard craft

production as semi-legitimate, typically for reasons of political expediency. One example is Ghana, which has no industrial arms manufacturing industry; Ghanaian gunsmiths continue to produce a large quantity of craft-produced small arms, much of which is exported to Nigeria (UNODC, 2015, p. 53). This issue is particularly acute in 'weak states', where the bulk of global craft production occurs, because governments are either unwilling or unable to enforce relevant international regulations (Batchelor, 2003).

Marking, record-keeping, and tracing

Many national and multilateral norms impose stringent marking requirements in connection with the manufacture of a small arm or light weapon. For example, EU Directive 2008/51/EC requires all EU member states to ensure that firearms manufactured in their jurisdiction be marked to enable tracing. Drawing on equivalent provisions in the Firearms Protocol and the International Tracing Instrument, the directive obliges members either to 'require a unique marking, including the name of the manufacturer, the country or place of manufacture, the serial number and the year of manufacture (if not part of the serial number)' or to 'maintain any other unique and user-friendly marking with a number or alphanumeric code' that allows easy identification of the country of manufacture by all members (EU, 2008, arts. 2(a)–(b); UNGA, 2001a, art. 8(1)(a); 2005, para. 8(a)).

Evidence indicates that the vast majority of improvised and craft-produced small arms and light weapons are not marked in accordance with national, regional, or international requirements and norms (ARES, 2018). Many craft-produced or improvised arms are not marked at all; in others, only the component parts—such as water pipe or staple guns—feature markings, typically those applied by commercial manufacturers; still others exhibit spurious markings applied to increase commercial value or confound law enforcement. On the whole, the markings on improvised and craft-produced weapons may sometimes allow for their unique identification, but the absence of record-keeping complicates tracing efforts by law enforcement officials.

In countries where national legislation requires the marking of all small arms and light weapons, these requirements also apply to improvised and craft-produced varieties. In EU member states, they pertain to all small arms and light weapons—without exception. In other states, some private individuals who produce firearms are not required to mark them. In the United States, for instance, individuals can manufacture firearms without a licence and without marking the weapons with serial numbers or other information, provided they do not transfer ownership of the unmarked weapons (by sale or otherwise) (ATF, 2017; US, 1968a, s. 923(i); 1968c, s. 5842(a)).[117]

However, the marking provisions of the Firearms Protocol and ITI make no exception for unlicensed individuals; while the Protocol refers to 'firearms' and the ITI to 'small arms and light weapons', both instruments oblige states to 'require' marking '[a]t the time of manufacture' (UNGA, 2001a, art. 8(1)(a); 2005, para. 8(a)). The ITI also states that:

> The choice of methods for marking small arms and light weapons is a national prerogative. States will ensure that, whatever method is used, all marks required under this instrument are on an exposed surface, conspicuous without technical aids or tools, easily recognizable, readable, durable and, as far as technically possible, recoverable (UNGA, 2005, para. 7).

In reality, the vast majority of craft-produced weapons meet neither the ITI requirements for the content of markings, nor its 'durability' requirement. Moreover, few, if any, records of such weapons are held in databases accessible to law enforcement officials for purposes of tracing and other types of arms and munitions investigations.[118]

Regulation of international transfers

While most improvised and craft-produced firearms are likely to be employed in the country in which they are manufactured, evidence points to an increase in the number of organized international transfers. They may occur within the relatively fluid border regions of conflict zones, such as between Iraq and Syria or Afghanistan and Pakistan; as part of semi-legitimate commercial arrangements, such as sales across the Ghana–Nigeria border; or in the context of trafficking by organized criminal groups, such as Croatian weapons shipped throughout western Europe, or Filipino guns sent to Australia (ARES, 2018; see Box 3).

The above-mentioned instruments—the Firearms Protocol, the PoA, and the Arms Trade Treaty—regulate the international transfer of craft-produced and improvised small arms and light weapons. They are written in such a way that the method of production is irrelevant (UNGA, 2001a, arts. 3(e), 5(1)(b), 10–11; 2001b, s. II, paras. 11–15; 2013).[119] As improvised and craft-produced small arms and light weapons are often produced and used illicitly, however, the individuals in charge of their transfer generally seek to evade international controls.

Regulation of design information

An additional regulatory option is to suppress the information necessary for the manufacture of certain craft-produced weapons. While the designs for a number of improvised and craft-produced weapons—including zip guns, slam-fire shotguns, sub-machine guns, anti-materiel rifles, and recoilless weapons—have been available by mail order catalogues for decades, many of the publications containing this information are now available from major online book retailers and are freely available online via various websites.

Some states have enacted legislation to regulate the possession or dissemination of information—including digital files or physical media—used in the design and manufacture of weapons. Before P.A. Luty, the author of a number of books on home gun-making,

died of cancer, he was being prosecuted under the UK's Terrorism Act of 2000 for 'making a record of information likely to be useful to a person committing or preparing an act of terrorism', as well as possession of an improvised firearm, in the form of component parts (Gardner, 2011). Legislation is increasingly changing to keep pace

Box 6 3D-printed firearms

3D-printed firearms drew widespread media attention in 2013, when Cody Wilson of Defense Distributed announced plans to build a fully-printable polymer weapon. In May of that year, he demonstrated and fired the single-shot polymer Liberator (Defense Distributed, 2013; McGowan, 2013).

International attention has also been focused on the proliferation of amateur-grade, additively manufactured firearms in jurisdictions outside the United States, especially where firearms are heavily controlled. One well-covered incident occurred shortly after Defense Distributed released the CAD files for its Liberator firearm, when two journalists successfully printed and smuggled an example onto a train running between the UK and France (Worstall, 2013).

It is now possible to produce a viable, multi-shot firearm using polymer 3D printing alone (Hodgkins, 2015). While current 3D-printed firearms are the products of polymer printing technologies, metal printing may come to the fore in the future. The most promising approaches play to the strengths of established and new technologies by fusing 3D-printed components and assemblies with traditional designs such as those produced by P.A. Luty (Jenzen-Jones, 2015d; see Box 1).

Rapid advances in 3D-printing technology and its increased application to the manufacture of firearms and firearm components raise a number of legal, normative, and law enforcement questions. 3D manufacturing will not render current international and national controls on firearms obsolete. It may, however, make applying these controls more difficult, in effect posing new law enforcement challenges. As additive manufacturing technologies continue to improve and become more readily available to private individuals, it will become increasingly difficult to enforce regulations on firearms manufacturing.

Private individuals and small groups currently face several important obstacles to the manufacture of 3D-printed firearms. These include the cost of printers and materials, the technical skills required, and the ability of the materials to withstand the temperatures and pressures associated with firearms (Birtchnell and Gorkin, 2013; Ferguson, 2014b). However, most analysts predict that the 3D-printing industry will experience a period of rapid growth in the near future. They anticipate growth in high-end manufacturing and design as well as in consumer-level printing (Jenzen-Jones, 2015d).

For the time being, however, the costs of purchasing or producing 3D-printed firearms, combined with their current operational limitations, are likely to make traditional firearms available on the black market more appealing to individuals and non-state armed groups.

Source: Jenzen-Jones (2015d)

with new developments in firearms production technology. A 2015 amendment to legislation in New South Wales, Australia, for example, created the new offence of 'possessing digital blueprints for the manufacture of firearms on 3D printers or electronic milling machines' (NSW, 2015).

Sharing weapon designs online may constitute an 'export' of restricted defence data, subject to an export licence. For example, in May 2013 the US Department of State directed Defense Distributed to remove design files related to the Liberator 3D-printed handgun from its website as it believed these constituted an export of restricted data (see Box 6). The department indicated that by posting these files online, Defense Distributed had potentially contravened the Arms Export Control Act (AECA) and its implementing regulations, the International Traffic in Arms Regulations (ITAR) (US, 1968b, s. 2778; n.d.a, ss. 120–30). The AECA and ITAR impose restrictions on the transfer of and access to controlled defence articles and related technical data. The restricted items and data, including firearms and technical data relating to firearms, are designated in the United States Munitions List (Cooke, 2013; US, n.d.a, s. 121). The legal issues surrounding the online sharing of design information related to small arms and light weapons have generated significant political discussion in recent years (Hsu and Feuer, 2018).

Forensic considerations and law enforcement challenges

Law enforcement officials regularly recover craft-produced or improvised weapons in certain states and territories, such as Australia, Brazil, Ecuador, Israel, Italy, and Palestine (ARES, 2018; ImproGuns and Jenzen-Jones, 2016). Some manufacturers produce crude improvised firearms solely for the purpose of generating income from gun 'buy-back' events (see Image 61). Such weapons have commanded as much as USD 300—even if they cost around USD 6 to produce (ImproGuns, 2014a).

Image 61 A particularly crude slam-fire shotgun allegedly taken to a gun 'buy-back' event in the United States

© Firearm Blog

Once they are recovered, craft-produced and improvised small arms and light weapons are generally difficult to trace. The unusual forensic footprint of these weapons complicates various tracing methods or renders them redundant.

The key problem is that most craft-produced weapons do not bear serial numbers—or that they feature fake ones. As a result, they cannot be run through the standard tracing procedures that are used to identify legitimate manufacturers and dealers involved in the production and transfer of weapons, which hinders investigative efforts. Tracing conventionally-manufactured weapons that bear a serial number can be a reasonably straightforward process, even when these items are manufactured in a different country, provided there is adequate record-keeping and state-to-state cooperation. In contrast, tracing improvised or craft-produced weapons tends to be problematic, even with a cooperative state partner. Even when the country of origin is known, states may be reluctant to admit that craft-produced or improvised weapons produced in their territory are being used in criminal acts or conflict zones abroad. Matching distinctive characteristics of craft-produced weapons may help to identify a particular illicit gunsmith, yet most of these weapons can effectively impede conventional law enforcement investigations, even in developed nations (Van Brocklin, 2015).

Craft-produced weapons can also present problems for ballistics investigations, which, when carried out on conventionally-produced firearms, serve to analyse the signature markings (tool marks) impressed into the soft metal of a projectile upon firing. Many craft-produced and improvised weapons feature smoothbore barrels with no rifling, and these can often have an internal diameter too large to reliably leave impressions on projectiles. Loose chamber tolerances can also be a problem in obtaining proper test results, as impressions left on 'sub-calibre' projectiles are often inconsistent (Sinha, 2015). Consequently, it can be difficult or impossible to prove beyond a reasonable doubt that a given projectile was fired from a specific weapon. In other cases, however, unique marks are left on projectiles after their passage through crudely rifled or otherwise distinct barrels.

When traditional forensic techniques are impractical, alternative methods can be applied. Specifically, the impressions left by the firing pin and the breech face of a craft-produced firearm can often be used to determine whether a particular type of weapon has fired a recovered cartridge or bullet. The firing pin indentation left on a cartridge primer, or extractor and ejector markings left on the cartridge case upon firing of a craft-produced firearm, are often irregularly shaped and will generally have a unique signature, which will allow them to be matched to a particular weapon. In one documented criminal case, however, the firing pin of a recovered weapon was attached to a string; it could thus be inserted when needed and potentially disposed of and replaced with a new firing pin (Sinha, 2015). The breech face of a firearm bears surface irregularities that are created during manufacturing, especially in crudely finished firearms. If a cartridge generates enough pressure during firing, these minute physical features are imprinted

on the cartridge head, and can later be matched by comparative microscopy. According to one government expert, the success rates for such procedures, while lower than those for conventional firearms, are relatively high. One of the current concerns in the forensics field is the need to increase the depth of available literature and sample cases using these techniques.[120]

“Although economically insignificant on a global scale, illicit craft production of small arms and light weapons is an important source of weapons in many countries.”

Conclusion

Illicit craft production of small arms and light weapons is widespread in many parts of the world. Although economically insignificant on a global scale, it is an important source of weapons in many countries (Batchelor, 2003). The number of illicitly manufactured improvised and craft-produced weapons is significant, particularly in areas with a long history of underground manufacture. In the Philippines, for example, illicit gun workshops have operated largely unchecked for more than 50 years. During a brief crackdown on these producers in 1972, a military sweep operation conducted under martial law amassed more than a quarter of a million illegally-manufactured firearms through confiscation and voluntary surrender (Ramos, 2005).[121] While more data is needed before researchers can arrive at a reliable estimate of the global number of improvised and craft-produced small arms and light weapons produced to date, the figure is doubtless in the millions.

In rare situations, users prefer improvised and craft-produced firearms to professionally-manufactured weapons. Far more often, improvised and craft-produced weapons are the only viable option. Non-state armed groups the world over employ these weapons because it is invariably less problematic to acquire the raw materials required for their production than the weapons themselves. In addition, increasing use of the Internet in recent years has permitted insurgents, engineers, hobbyists, and criminals to communicate methods of manufacture, spurring craft production. Even the need for basic manufacturing experience is likely to decrease in response to advances in 3D-printing technologies.

In the future, it may be possible to bypass traditional manufacturing entirely and instead to produce entire firearms by means of additive manufacture. The Solid Concepts 1911 DMLS, a Colt 1911-pattern pistol produced by direct metal laser sintering, was an early example of this potential, although the technology remains cost-prohibitive for now.[122] In the meantime, craft producers have begun to embrace older, anonymous technologies that were widely adopted by commercial manufacturers, including CNC machining, despite limitations arising from the relatively high cost of machinery and a required level of operator skill (Greenberg, 2014). Such machines may be used to augment more traditional approaches.

Over time, manufacturers will adopt new technologies to produce higher-tier improvised and craft-produced weapons. For now, however, those who cannot obtain conventionally-produced alternatives will continue to manufacture weapons using relatively low-tech means. Any individual who has access to ammunition simply needs basic fabrication skills and equipment to produce a crude but viable firearm. In many cases, the materials are available at the local hardware store. Regardless of how they are made, improvised and craft-produced weapons will remain a significant constituent in the arsenals of non-state actors and criminal groups. At the same time, they will continue to pose global challenges to law enforcement and policy-makers, who will require increasingly thorough documentation of their use in crime and conflict to be able to recognize trends and curb illicit proliferation. ●

Endnotes

1 Many sources consider 'converted firearms' (such as blank-firing guns that are modified to chamber and fire lethal-purpose ammunition) and 'reactivated' deactivated firearms a subset of improvised and craft-produced types. This report treats them as separate categories in view of technical and regulatory distinctions.

2 This report covers small arms and light weapons as defined in ARES (2017). Since improvised explosive devices are not classified as small arms or light weapons, they are excluded from the study, although Section II touches on their developmental history in the context of improvised arms and munitions.

3 For security and privacy reasons, this report does not identify all interviewees by name or cite all interview locations. Similarly, it refers to secondary sources in lieu of citing sources that may promote illicit arms proliferation or misuse.

4 Finished firearms or pressure-bearing components, such as a barrel, slide, or receiver, are fired with an increased charge of propellant, generating pressures in excess of what the weapon would typically be expected to endure through normal use. If the gun remains intact following this procedure, it is typically marked with a 'proof mark' to indicate a successful test (Gunmakers, n.d.).

5 The term 'conversion' is sometimes applied to a modified deactivated weapon to indicate that it has not necessarily been 'reactivated' to its full, original capabilities, but that it still poses a lethal threat. If, for instance, a deactivated self-loading rifle has its rifled barrel replaced with a smoothbore barrel, the weapon can no longer be considered a 'self-loading *rifle*'. Broadly speaking, a deactivated firearm is one that has been altered in such a way that it is no longer capable of discharging a projectile (Ferguson and Jenzen-Jones, 2016). The degree to which such an alteration may be considered permanent varies by situation and in accordance with applicable regulations. The conversion and reactivation of firearms are addressed in more detail in Florquin and King (2018).

6 In many cases, the conversion of blank-firing or deactivated firearms provides the maker with a head start, potentially allowing for faster production or a more effective end product.

7 US requirements regarding how these weapons are cut or disassembled have changed several times over the years. Until a few years ago, all parts other than the receiver (including other pressure-bearing components, such as the barrel) could be imported intact. For more information, see ATF (2016).

8 See p. 56.
9 See pp. 77 and 103.
10 The attempt resulted in the death of the operator (NMI, n.d.).
11 See p. 66.
12 'Slam-fire' weapons are characterized by a simple design in which a chambered cartridge is brought in contact with a fixed firing pin under human power, without the aid of any additional mechanical firing mechanism.
13 See, for example, California's Penal Code, which specifically names the 'zip gun' (California, 2010).
14 Author interviews with law enforcement and intelligence sources, 2014–17.
15 Author interviews with law enforcement and intelligence sources, 2014–17.
16 In the mid-1990s, a detailed diagram of the PRIG from a restricted British Army document was reproduced in another cookbook (Jenzen-Jones, 2017a). See p. 101.
17 See p. 86.
18 Author interviews with law enforcement and intelligence sources, 2014–17.
19 Anwar (2015); Guanzon-Apalisok (2013); Hinshaw (2014); *India Today* (2013); McGeown (2013); author interviews with law enforcement and intelligence sources, 2014–16.
20 See, for example, Berthiaume (2018) and *Inquirer* (2013).
21 These techniques are primarily employed to preserve a firearm, as they discourage the formation of destructive oxides such as rust (iron oxide) on the surface of the metal components (Jenzen-Jones and Ferguson, 2018a).
22 Broaching is a machining process that involves pushing a cutting tool, known as a broach, through the material in question (Miles, 2016). Less commonly, cut rifling (also called 'single-point rifling') techniques may be employed to the same effect (NRA, 2017).
23 A barrel blank is an unfinished barrel in any stage of completion. Most commonly, it is a rifled tube that has not been profiled nor cut for a chamber or other features (such as a crown or threads).
24 Author interview with an intelligence source, April 2016.
25 Author interview with a law enforcement source, 2016.
26 See p. 116.
27 Author interview with a law enforcement source, June 2016. See also Pavlovich (2016).
28 The Liberator is based on a simple, sheet-metal pistol design reminiscent of craft-produced handguns; see McCollum (2015b).
29 Currencies are converted to US dollars using the 1 November 2017 exchange rate.
30 The price was EGP 300–500 before the revolution.
31 The price was CNY 300 in the Songtao Miao Autonomous County.
32 Qassam rockets are named after the Izz ad-Din al-Qassam Brigades, the armed wing of Hamas. The brigades are named after Izz ad-Din al-Qassam, a Syrian Muslim preacher who died in 1935 during a standoff with British police officers in Mandatory Palestine (Milton-Edwards, 1999). The name 'Qassam' or 'Kassam' is often used by analysts as a catch-all term to refer to a series of craft-produced rockets made by different groups and with differing capabilities.
33 ARES (2018); Jenzen-Jones and Wright (2016); Lyamin and ImproGuns (2017); McCollum (2017).
34 Sand casting is a metal-casting process that uses sand as the mould material. A majority of metal castings are made using sand-casting techniques (Rao, 2003).
35 See, for example, Rogoway (2014).
36 Author interviews with law enforcement and forensic sources, 2014–16.
37 See p. 44.

38 Windage is the difference between the diameter of the bore and the projectile. Excessive windage allows propellant gasses to 'blow by' the projectile, reducing velocity and accuracy (Denny, 2011).
39 Author interviews with a researcher, UK, 2015, and with tribal representatives, Nigeria, 2014–15.
40 See p. 67.
41 Author interviews with a researcher, UK, 2015, and with tribal representatives, Nigeria, 2014–15.
42 See p. 66.
43 Online author interviews with nature conservation and law enforcement sources, 2015–16.
44 See p. 56.
45 Modern loadings of .416 Remington Magnum, for example, have a maximum average chamber pressure in service of approximately 65,000 psi, or pounds per square inch, which is equivalent to 540 CUP (copper units of pressure)/100 (ANSI, 2015, pp. 356, 360).
46 Author interviews with law enforcement sources, 2015–16.
47 Author interview with an intelligence source, April 2016.
48 More advanced and capable improvised and craft-produced small arms—and light weapons—have been recovered by law enforcement in Northern Ireland. See Box 4 and p. 77.
49 Author interview with an intelligence source, April 2016.
50 See endnote 5.
51 Author interviews with law enforcement and intelligence sources, 2014–17.
52 Author interviews with law enforcement and intelligence sources, 2014–17.
53 The sub-machine gun appears to make use of components identical to those seen on the Croatian Zagi M-91 sub-machine gun, a modernized derivative of the British Sten gun produced during the 1991 Croatian war of independence. Significant differences suggest that it has been purpose-built rather than modified from the original Zagi: the cocking handle guide is positioned on the left-hand side of the receiver rather than the right-hand side, and the design employs a more compact trigger group, housed in an identical but shortened MP5-style plastic grip assembly. These similarities indicate that individuals with prior experience in the manufacture of the Zagi M-91—or at least access to a surplus of original components—may have been involved in the production of these new firearms (ARES, 2015).
54 The small arms included copies of Italian Beretta self-loading handguns and US M3 'grease gun' sub-machine guns, as well as crude revolvers (ARES, 2018).
55 Author interviews with British law enforcement and intelligence sources, 2015–17.
56 Quasi-state forces include internationally-supported wildlife ranger units, which retain state authority.
57 See p. 67.
58 Most small-calibre cartridges make use of a 'primer', a small metallic cup containing an impact-sensitive chemical compound that is struck by the firing pin of a weapon, releases energy quickly, and ignites the propellant in a cartridge. The primer is centrally located in the head of the cartridge case; cartridges using this method of priming are known as centrefire cartridges (Jenzen-Jones, 2018).
59 Some types of match heads require the user to perform processing.
60 A hang fire occurs when there is an unexpected delay between the functioning of the trigger mechanism of a gun and the ignition of the propellant.
61 This method closely simulates the one first patented in late-18th-century England. As the molten lead falls, surface tension causes it to form spheres, which solidify as they cool on descent. The water cushions the spherical shot on impact, helping to retain its shape and

hardening it further (Minchinton, 1993). In many cases, improperly prepared shot, in which the molten lead has partially cooled before it is poured, or is poured from an insufficient height for its size, has a signature 'tail' and a tear-drop shape. Examples have been documented in several African countries (ARES, 2018).

62 The etymology of the term remains unknown.

63 Author correspondence with David J. Van Pelt, historian and author, 2016.

64 Author interviews with law enforcement and intelligence sources, 2014–16.

65 The term 'Danegun' appears to have originated in the 1700s as a result of the high value placed on flintlock guns of—real or perceived—Danish origin in western Africa (Christopherson, 1975).

66 Author interviews with nature conservation and law enforcement sources, 2015–17.

67 Author interviews with law enforcement and intelligence sources, 2015–17.

68 *Desi katta* means 'locally-made gun'. While the term is most commonly applied to single-shot pistols, it is increasingly used to describe more sophisticated weapons, such as self-loading pistols, which have begun to replace the older types in parts of India (ARES, 2018; Joshi, 2015).

69 Blowback operation is a self-loading firearm action in which the bolt is not locked to the breech on firing, but rather held in place only by its own inertia and the return spring. It is suitable only for relatively low-pressure ammunition, such as handgun cartridges or cartridges for automatic grenade launchers (Ferguson et al., 2015).

70 Many of these weapons are configured as weapons sometimes referred to as 'machine pistols'.

71 Author interviews with intelligence and law enforcement sources, 2014–17; ARES (2018). For numerous examples of improvised and craft-produced small arms and light weapons seized from criminal users, see ImproGuns (n.d.).

72 Most craft-produced sub-machine guns are chambered for pistol-calibre cartridges, including 9 × 19 mm, 9 × 18 mm, and .380 ACP (ARES, 2018; Jenzen-Jones, 2017a).

73 See p. 56.

74 These groups included the Ulster Volunteer Force, Ulster Defence Association, and Ulster Freedom Fighters.

75 Author interviews with intelligence and law enforcement sources, 2014–17.

76 Despite some observers' claims, this design does not appear to feature a semi-telescoped bolt as in the case of industrially-produced firearms, such as the Israeli Uzi or Czech Sa vz. 23 series, or as seen in some craft-produced sub-machine gun designs from Northern Ireland.

77 The '8MM K' portion of the marking may be a rudimentary effort to make the firearms appear as though they are chambered for a blank (8 mm PAK, sometimes known simply as '8 mm K') cartridge and therefore not lethal-purpose weapons.

78 Some outlaw motorcycle clubs refer to prospective members as 'prospects'. Generally, prospects are individuals who have shown some level of commitment to the club and may wear an abbreviated version of the club's insignia (Barker, 2007).

79 Some of the larger-calibre weapons colloquially known as 'anti-materiel rifles' are properly considered light cannon and hence classified as light weapons, rather than small arms. The distinction between the two categories is, in part, based on an upper-calibre limit of 20 mm for small arms (ARES, 2017).

80 Source withheld.

81 Assessment based on information and images of these weapons supplied to ARES by a confidential source who served in a YPG sniper *tabor* (platoon) from June 2015 to August 2016; see McCollum (2017).

82 Hobbyists in the United States have manufactured very similar single-shot rifles. The most popular of these designs is based on a popular instructional video and its associated book (Jenzen-Jones, 2017a).

83 Cup-type launchers remain in service with some law enforcement agencies, particularly in the developing world.

84 'Molotov cocktail' is a colloquial term for any number of crude incendiary devices. They generally consist of a glass bottle filled with flammable liquid and fitted with a means of ignition.

85 The term 'safety fuse' originally referred to an 1831 patent for a design in which black powder was wrapped in cord and varnished or tar-coated, so as to provide a water-resistant fuse that burned at a near-constant rate (Ellsworth, 1936). In modern usage, it may refer to similar arrangements also known as plastic igniter cord.

86 Broadly speaking, a grenade launcher is a gun that fires medium-calibre explosive projectiles at relatively low velocities (Jenzen-Jones, 2015a).

87 The effective range is unlikely to be 2 km. Manufacturers indicate that the maximum range of the projectile is 1,700 m (Rosoboronexport, n.d.).

88 It is not clear how effective this method is.

89 Source withheld.

90 Other sources have claimed, incorrectly, that these munition bodies were produced using plastic moulding techniques.

91 Such munitions carry a main charge of up to 50 g of ammonium nitrate aluminium (AN/Al) explosive composition. Islamic State manufacturers have made extensive use of this mixture in suicide vehicle-borne IEDs and other improvised munitions (Fulmer and Jenzen-Jones, 2017). Other sources have incorrectly claimed that the main charge was a PETN-based composition.

92 Assessment based on imagery analysis (open source and other) and author interviews with deployed forces, 2016–18.

93 Some visually-similar examples do not propel an explosive projectile, instead using the propellant to propel kinetic projectiles such as nails, marbles, or ball bearings. These weapons would be more properly described as improvised shotguns. Nonetheless, it is typically possible for the same weapon to fire both types of projectiles, and hence 'improvised grenade launcher' remains a useful and accurate description.

94 In some cases, such munitions are also thrown as improvised hand grenades (ARES, 2018).

95 Recoilless weapons are direct-fire support weapons distinguished by a system of operation in which propellant gasses (or other types of countermass, such as powders or liquids) are expelled from the rear of the launch tube or barrel to 'balance' the recoil of firing. Whereas early recoilless weapons used a solid metal countermass, modern ones generally make use of propellant gasses (Jenzen-Jones, 2015c).

96 The Moro Islamic Liberation Front also produced copies of the US M79 grenade launcher, as well as several craft-produced AMRs, as discussed above (ARES, 2018).

97 The composition was usually a Semtex-type RDX–PETN blend plastic explosive (ImproGuns, 2014b).

98 Shaped charges are commonly used in high-explosive anti-tank munitions. In such munitions, the explosive filling features a conical cavity in the front that is lined with a thin metal sheet (typically copper). Upon detonation, this metal is forced into a thin jet with an extremely high velocity that is able to penetrate armour (Cross, Dullum, and Jenzen-Jones, 2016).

99 Digestives are semi-sweet biscuits that are popular in the UK. The household cleaning cloth used to limit the felt recoil was not woven, but rather produced using spunlace/hydroentanglement, a method used in J-cloth brand fabrics, which are primarily viscose (Butler, 1999).

100 Mortars are normally smoothbore, muzzle-loading, indirect-fire support weapons that allow the operators to engage targets that may not be within their line of sight. Many mortars are restricted in elevation, only capable of firing at high-angle trajectories (more than 45°), meaning that they cannot be used in the direct-fire support role. Some mortars, however, including craft-produced mortars, are capable of direct fire (Jenzen-Jones, 2015b). While the Small Arms Survey typically considers mortars up to and including 120 mm in calibre to be light weapons, this report examines some larger systems in view of their design similarities and linked employment histories.

101 Phlegmatizer is a compound added to a high-explosive composition to stabilize or desensitize it.

102 Projectiles for smaller mortars may use improvised or conventional propellants, or even propelling charges intended for use with industrially-produced mortar projectiles, if available (ARES, 2018).

103 Functioning of the projectiles can occur via impingement-type (pin) impact fuze, or via a weighted inertia pellet positioned behind a percussion detonator, often incorporating a small-calibre blank cartridge (ARES, 2018; Jenzen-Jones, 2017a).

104 Similarly concealed weapons have been employed elsewhere; the Mahdi Army fired a series of improvised rocket-assisted mortars from a concealed configuration within a cargo truck in Baghdad in 2008 (Roggio, 2008).

105 Larger, vehicle-borne improvised systems are also employed, although these are beyond the scope of this report. For further information on improvised vehicle-mounted systems employing conventionally-manufactured air-to-surface rockets, see Lyamin and Jenzen-Jones (2014).

106 Some rockets require more advanced ignition methods, but these are seldom held by non-state armed groups or other actors.

107 Adapted from Fulmer and Jenzen-Jones (2017) and Wright and Jenzen-Jones (2018).

108 For further information on the use of improvised and craft-produced air-delivered munitions used in conjunction with UAVs, see Wright and Jenzen-Jones (2018).

109 When toxic industrial chemicals are weaponized, they are considered chemical weapons under the Chemical Weapons Convention (CWC, 1993). Other chemical weapons have also been employed in Syria (ARES, 2018).

110 Syrian opposition image posted on Facebook but since removed.

111 On the basis of the terminology used in the 1997 report— 'shells and missiles for light weapons'—it could be argued that some light weapons ammunition is not covered, since few light weapons are designed to use projectiles or rockets that are known as either 'shells' or 'missiles'.

112 The full names of the agreements are: Protocol against the Illicit Manufacturing of and Trafficking in Firearms, Their Parts and Components and Ammunition, supplementing the United Nations Convention against Transnational Organized Crime (UNGA, 2001a), and International Instrument to Enable States to Identify and Trace, in a Timely and Reliable Manner, Illicit Small Arms and Light Weapons (UNGA, 2005).

113 The definition does not cover certain types of weapons, such as speargun-type weapons (designed for underwater fishing) and some pneumatic weapons.

114 A limited number of craft-produced weapons, such as coil guns, spearguns, and pneumatic weapons, are not covered by this definition.

115 For a discussion of the weapon types covered under the Arms Trade Treaty and ITI, see Clapham et al. (2016, pp. 104–24).

116 Full name: United Nations Programme of Action to Prevent, Combat and Eradicate the Illicit Trade in Small Arms and Light Weapons in All Its Aspects. See UNGA (2001b).

117 See also Giaramita (2014); Johnson (2017); US (n.d.b, ss. 478.11, 478.92(a), 479.102(a), 479.102(c)). For a useful reference guide to relevant US firearms laws, see ATF (2014, pp. 7–31).

118 Author observations and interviews with law enforcement sources, 2015–17.

119 The Arms Trade Treaty's application to parts and components is partial (Parker, 2014, p. 82).

120 Author interviews with forensic scientists, 2015 and 2017.

121 Almost 60 per cent of these weapons were made in Danao (Ramos, 2005).

122 For a discussion of additive manufacturing and the firearms industry, see Jenzen-Jones (2015d).

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Table 2 Pricing of selected improvised and craft-produced weapons

Type	Country	Model	Price[29]	Source
Pen guns and zip guns	Australia	Modified automatic centre-punch	AUD 100 (USD 80)	Partridge (2014)
		Pen gun	AUD 100 (USD 80)	Harris (2015)
		Various zip gun designs	AUD 100 (USD 80)	Morri (2015)
	Thailand	.22 LR & .38 Special	THB 800–1,450 (USD 24–43)	ARES (2018)
Shotguns and muzzleloaders	Nigeria	Dane gun	USD 50	Hinshaw (2014)
		Muzzle-loading shotgun	USD 24	Hinshaw (2014)
	Thailand	Slam-fire shotgun	THB 1,500 (USD 45)	ARES (2018)
Single-shot pistols	Egypt	Fard/marotta	EGP 500–1,000[30] (USD 28–56)	Elmeshad (2011)
	India	Desi katta	INR 500–1,000 (USD 8–15)	Bhosle (2015)
	Thailand	.22 LR 'derringer'	THB 3,900 (USD 117)	ARES (2018)
		Break-barrel (12-gauge)	THB 6,800–8,000 (USD 200–240)	ARES (2018)
		Break-barrel (.38 Special)	THB 6,100–7,000 (USD 180–240)	ARES (2018)
Revolvers	Philippines	NNA mini copy (.22 LR)	AUD 150 (USD 120)	Pavlovich (2016)

Type	Country	Model	Price[29]	Source
Self-loading pistols	China	Type 64 copy	CNY 10,000[31] (USD 1,500)	Hu (2010)
	India	'Morena'/MP pistol	INR 5,000–6,000 (USD 78–90)	Agha (2014)
	Libya	.32 ACP design	LYD 600 (USD 450)	ARES (2018)
Sub-machine guns	Australia	Ingram MAC type	AUD 15,000 (USD 11,840)	Hills (2013)
		P.A. Luty type	AUD 15,000 (USD 11,840)	Fewster (2014)
		Ingram MAC type	AUD 5,000–15,000 (USD 3,950–11,840)	Pavlovich (2016)
	Brazil	Ingram MAC type	BRL 5,000 (USD 1,560)	Ferreira (2016)
		Sten type	BRL 5,000 (USD 1,560)	Lombardi (2002)
		Sten type (very crude)	USD 1,250	ARES (2018)
		Various	BRL 3,500 (USD 1,090)	ARES (2018)
	Israel/Gaza	'Carlo' (unrifled)	USD 500–1,000	ARES (2018)
		'Carlo' (unrifled)	ILS 3,000–10,000 (USD 750–2,500)	Gross (2016)
		'Carlo' (rifled)	ILS 10,000–15,000 (USD 2,500–3,800)	Gross (2016)
	Philippines	Ingram MAC type	AUD 400–1,500 (USD 315–1,800)	Pavlovich (2016)
	Russian Federation (Chechnya)	Borz	USD 100	Dudayev (2004)